SCIENTIFIC AMERICAN SUPPLEMENT. No. 966

Copyright by Munn & Co., 1894.

Scientific American Supplement, Vol. XXXVIII. No. 966.
Scientific American, established 1845.

NEW YORK, JULY 7, 1894.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

A RACE BETWEEN PEDESTRIANS, STILTSMEN AND HORSES.

DURING the years 1892 and 1893, we gave an account of some very original races between stiltsmen that were got up by the *Petite Gironde*, along with some other journals that rank high in the country. These races took place on Ascension Day.

This year, it was desired to make a comparative test of pedestrians, stiltsmen and horses in harness.

It happened, as was expected, that the number of those desiring to enter was so great that the surveillance of such a contest would have been almost impossible, so the applicants were told that a selection would be made and that three special committees would choose three racers in each category.

The start took place at twenty minutes to ten on the morning of May 3, at Bastide, a faubourg of Bordeaux, upon the right bank of the Garonne. The route to be taken passed through Libourne, Bergerac, Mussidan, Perigueux, Angouleme, Cognac, Saintes, Blaye and Bordeaux. The length of the course was exactly 250 miles.

At the start the horses took considerably the lead, and then came the pedestrians, and finally the stiltsmen, who walked with a methodical deliberation that argued well in their favor.

At Bergerac (55 miles) the horses were still ahead, but the first horse was an hour and a half in advance of the last. The stiltsmen had taken second place, and the walkers, one of whom had already dropped out, followed far in the rear.

At Perigueux (90 miles) the horses were still in the lead, while one of the stiltsmen had taken the third place, preceding the horse Charlatan by two hours. One of the pedestrians, Dufour, of Rouen, arrived at eight minutes of eleven in the morning, having made the 90 miles in a little over twenty-four hours. The first horse had made the distance in 14 h. 27 m., and the first stiltsman in 19 h. 6 m.

At Mareuil-sur-Belle (120 miles) the first horse arrived at 9 h. 45 m., having thus made about 120 miles in twenty-four hours. Such a result is magnificent, and leaves very far behind it a recent performance of the mare Merveilleuse, which caused some excitement at Paris not long since. The latter made but 82 miles in the same interval of time.

One of the horses came to a stand, having become ill, but the one that was in the rear of the first stiltsman had got ahead of him at the arrival and started again behind him.

At Angouleme (141 miles) the order had not changed—two horses only and three stiltsmen being in the race, the other competitors having dropped out.

At Jarnac (160 miles) the two horses arrived between eight and nine o'clock Friday night, and took a rest. Charlatan had broken his vehicle and his driver mounted him, the conditions of the race permitting of such a change, but the understanding being that the horse should not be put in harness again.

The first stiltsman, who arrived during the night, immediately started off again; so he was the first to register at Saintes (180 miles), which he reached after 44 h. 44 m. of travel, having made an average speed of, say, 4¼ miles an hour.

The ridden horse followed close on, while the other was giving certain signs of exhaustion.

At Pons (195 miles) the stiltsman and saddle horse were abreast, and a neck and neck contest arose between them that terminated only at Bordeaux, in a victory for the horse, which beat his competitor by 28 minutes.

The total run was made in 62 h. 27 m., which beats the record of Merveilleuse by nearly 28 hours. The winning horse, Charlatan, had made a mean speed of 4 miles an hour.

These unlooked for results greatly excited the inhabitants of Bordeaux, and it is fitting to congratulate the *Petite Gironde* for the public experiments upon

FIG. 1.—THE PEDESTRIANS OF THE BORDEAUX RACE OF MAY 3, 1894.

the endurance of men and animals that it has been repeating for the last two years.

Let us say in conclusion that the horseman and stiltsman were in perfect condition, a fact which, *a priori*, seems extraordinary.

The following are the results of the medical examination: Florange, horseman, 51 years of age, 126 pulsations and 25 respiratory motions per minute; Fauconneau, stiltsman, 32 years of age, 108 pulsations and 18 respiratory motions. After such an effort these conditions of health are perfectly satisfactory.—*La Nature.*

A JAPANESE HOTEL.

DESCENDING from the hilltop, and making our way to the village, we took up our quarters for the night at a native inn, the Shio-to-quan. This was our first experience of such entertainment, though destined not to be the last. This house was neat and airy, with open windows and balcony, perched on a little knoll, and looking off upon the water and the islands. We called it "The House of the Seven Gables," from its quaint appearance. Whether that was the meaning of its name I do not know, though it might easily have been. The first thing for an arriving guest to do is not to register his name, but to take off his shoes. This is the indispensable condition of entrance to a true Japanese house, as of the temples and many of the places for Christian worship. The reason is at once apparent, for the floors are covered with thick matting, kept scrupulously clean, on which the people sit without intervention of chair or stool. Aside from the desire for cleanliness, the sharp heels of foreign shoes would soon make havoc of the mats.

A true Japanese dinner was served us in the evening, in lacquered trays set before each as we were seated on the floor. The food consisted chiefly of fish—cooked in different ways—soup, a few other vegetables, and a bowl of rice—all to be eaten with chop-sticks. The people who use these implements far outnumber those who employ knives and forks, and the expedition with which a good meal can be eaten with their aid by an expert is simply marvelous. Where every smallest child is such an expert, the almost helpless foreigner feels his inferiority. With the introduction of lights the ubiquitous mosquito makes his already suspected presence more distinctly felt. No country enjoys a monopoly of these "birds of prey." To ward them off and make sleep possible, a huge net is brought in and suspended from the four corners of the room. Beneath its spreading folds four beds are spread upon the floor—layer upon layer of thickly wadded quilts, cotton, and silk—with one for covering. Stretched upon these and sheltered by the net we slept and were refreshed, unmindful of mosquitoes and forgetful of Matsushima and its charms.—*Christian Intelligencer.*

[FROM THE NEW YORK TRIBUNE.]

UNDERGROUND LIFE AND LABOR IN THE ANTHRACITE REGION.

WHATEVER just grounds may exist for the bituminous coal strike, there are certainly none whatever for any strike in the anthracite regions. The miners in the Wyoming and Lehigh regions are thrifty, receive good pay, work comparatively few hours; their labors have been lightened by the most modern appliances which the operators have been able to obtain to secure safety and comfort, and the spirit of contentment generally prevails.

The miners of northeastern Pennsylvania have been decided gainers by the misfortune of the soft coal workers; an unprecedented demand has been caused for anthracite in this section by the scarcity of soft coal at the seaboard, and the miners all the way from Lehigh to Carbondale are working full time. It is not likely that the miners who are benefited so greatly by the Western miners' misfortune—with whom there exists no strong bond of sympathy—will for the sake of mere sentiment vote themselves out of a condition of prosperity into one of misery, especially when they have everything to lose and nothing to gain by it. It is more than a score of years since there has existed any serious disagreement between the operators and mine workers of this section concerning wages.

Investigation into the conditions of the miners, their methods of working, their treatment by their employers, commonly known as the "coal barons," in the very

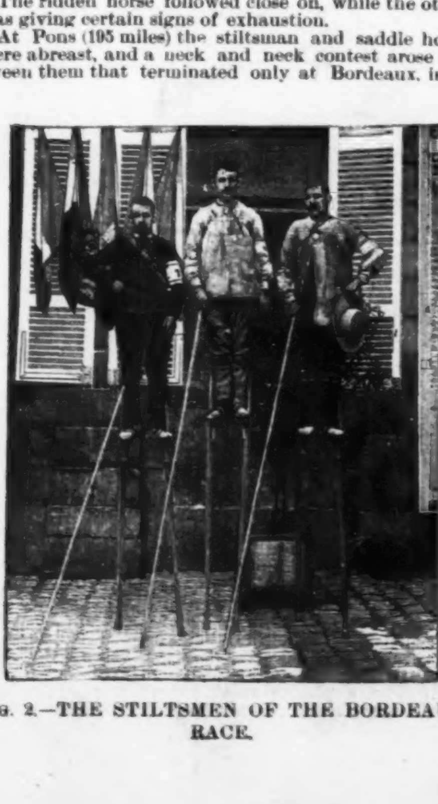


FIG. 2.—THE STILTSMEN OF THE BORDEAUX RACE.

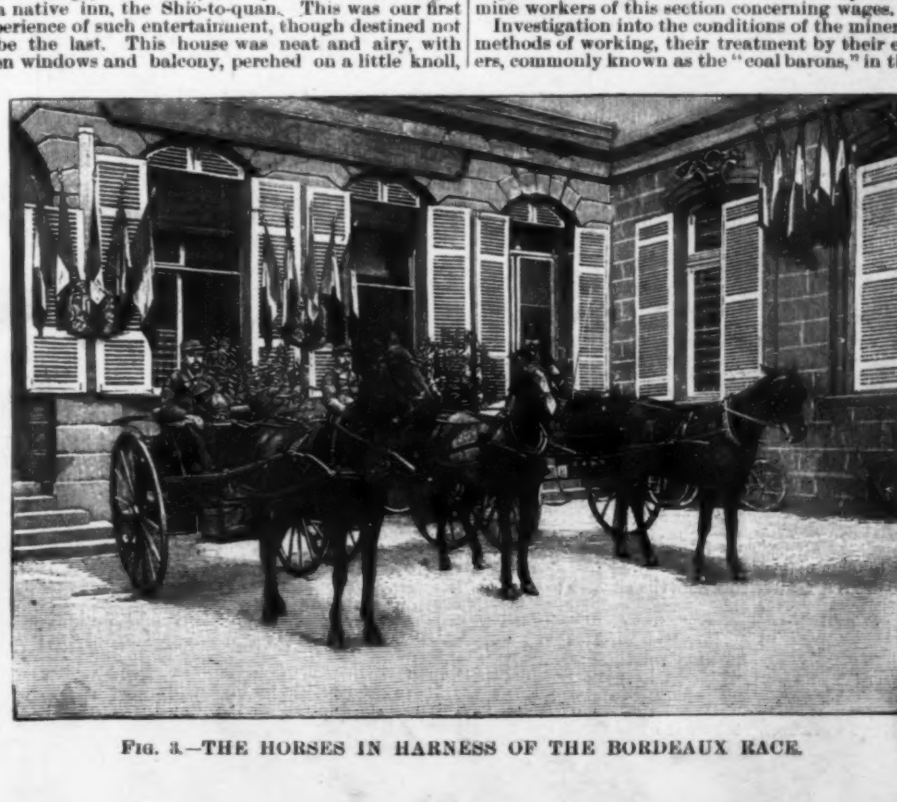


FIG. 3.—THE HORSES IN HARNESS OF THE BORDEAUX RACE.

center of the anthracite region of Pennsylvania, sheds light upon a much distorted subject and reveals a condition of affairs entirely at variance with what has generally been published concerning the lives and labors of mine workers. The picture which has been repeated ad nauseam for years has been that of a miserable toiler bent down by relentless fate beneath the iron hand of a cruel master, delving as in a subterranean prison, among gangways dimly lighted and only by flickering torches on miners' caps, laboring incessantly day and night, then receiving only a pittance for the labor, and repairing after each day's exhausting efforts to some humble home, where wife and children wanting for food herd in a most pitiable condition. In brief, the anthracite miner has been portrayed in abject misery and forlorn drudgery as hardly above the Siberian exile.

To the ordinary reader there has always existed a weird fascination, which has been aided by lurid pictures, representing these toilers under the ground with pickaxes in hand, flitting about like demons described in the grewsome delineations of Dante. Imagination has lent its aid to thoughts about these grotesque toilers, regarded frequently as little better than prisoners serving life sentences, laboring as continuously and unceasingly as Sisyphus with his stone or Ixion on the wheel. Personal visitation to the various mines of the anthracite region, made at all seasons of the year, under all conditions, aided by photographic snap shots taken at unprepared times, induces me to say, without fear of contradiction, that under the operations of restrictive mining laws, with the advantages of modern appliances, aided by humane sentiments and the advances of electricity, the condition of the anthracite miner at this time is, and has been for some time past, in many respects far better than that of other skilled mechanics. The once dark and gloomy entrances to the mines by the aid of electricity alone have become completely transformed, so that the gangways and breasts, illuminated by incandescent lamps, have become converted into picturesque and attractive caverns, more of the character of the captivating subterranean chamber described in the story of Aladdin than places of doom or incarceration.

As an illustration may be cited the Mount Lookout colliery of Simpson & Watkins—two of the most successful and wealthy coal operators in the Wyoming district—where an electric hauling plant has recently been put in place. The generating apparatus is in the engine house, on the surface. There is what is called a multipolar generator of 100,000 volts capacity, operated by a high speed steam engine. From the generator in the engine house the electric feed wire is carried down the air shafts 1,000 feet, and then begin the trolley wires, of which there are 3,300 feet. The inside plant is situated on the south side of the shaft, at the foot of a slope several hundred feet in length. Here four three-mule teams, with a driver for each, were heretofore required to gather the coal and bring it to the foot of the slope. One electric locomotive now does the work in a satisfactory manner. The locomotive is small, although full of condensed power, being thirty-two inches high and eleven feet six inches long, and of three foot gauge.

All it consists of is the frame, motors, sand [illegible] and operating levers. Of the latter there are two, one for the control of the current and the other for the hand brakes. Incandescent lamps are arranged at both ends and send rays of light a considerable distance ahead, which, striking upon the shiny surface of the roof of coal and the sides of the same, make the place particularly attractive and picturesque. It has been demonstrated that electricity is superior as a motor power in and about mines. One hundred incandescent lamps illuminate the principal points in the Mount Lookout colliery. In many respects the condition of the miner is better and his comparative freedom from danger is greater (although disasters still occur from flooding by water, from cavings and from gas explosions) than mechanics operating on the leading railways. Taking into consideration the number of persons employed, there were fewer fatalities in the anthracite region last year than on the world's railroads.

Of course, there are persons who work in the mines as miners who are not strictly so; and such men would make poor wages anywhere; but one who is an expert at coal mining invariably makes good wages without working over seven hours daily. He lives, moreover, in comfort, far beyond that of the average toiler in our factories. Since the mine laws have been passed and made operative, extra protection has been placed around the men; and with the improved system of ventilation universally prevailing in the anthracite region, and the inspection which is unrelaxing, the miner has not only a comparatively easy, but a happy time of it. Instead of this class of persons being a gloomy and a morose set, there is probably in no department of endeavor a happier, jollier, or more contented body of men. The uniformity of temperature which prevails in the mines—by means of the ventilators now in use—makes them desirable places in which to labor. If a miner were asked to take his choice between opening a ditch on a hot summer's or a cold winter's day or working in the mines, he would not hesitate a second. Even if the price paid for digging the ditch were higher than that of mine working—the contrary being the case—he would prefer the mining.

One reason for this is that the temperature is uniform, being at sixty-five degrees, Fahrenheit, all the year round. He is not subjected to the changes of temperature as is the day laborer on the earth's surface; the fans which are continually in operation keep the air in a condition of remarkable purity; he is not subject to colds or ailments which affect those who labor above the earth, through sudden changes of temperature. All the disagreeable attendants and surroundings which used to prevail in the mines are gone.

The persons to whom those who sit comfortably around their cheerful fires are indebted for exhuming the coal and bringing it upon the surface are as follows:

First, the mine boss. He performs duties similar to those of a foreman in a machine shop. He is a man amenable to the mine law, and in that respect is a State officer. It is his business to see that the provisions of the law are carried out, and with this in mind he organizes his forces and distributes them in the different workings. There is little variation from the well-known conditions of mining. The old form of gangway running along the center of the workings, with breasts for each miner to work in, prevails now as of old. The mine boss must thoroughly understand ventilation and see that all the provisions of the law are carried out. He is required to exercise general supervision over the workings of his particular section of the mine, and he works ten hours. He receives from $75 to $150 a month, according to efficiency and time of service. He assigns the different miners to their particular breasts, sees that sufficient coal is mined each day for the cars, and looks after the ascent of the latter to the surface.

The next person in charge is the assistant boss. His duties are like those of an assistant foreman in a machine shop. He is of general utility, passes from one man to another, aids the mine boss in every way that the latter may require, works ten hours, and receives $60 to $100 a month, according to efficiency and length of service.

The next in order is the fire boss, whose business it is to examine for gases. In gaseous mines he fires the shots himself, taking the position of greatest peril, which it is his place to discover, if it exist. The usual test for these gases is the old Humphry Davy lamp, which the miners seem to prefer to all others; although there are various imitations which are in use to some limited extent, prominent among which is the Ashworth-Hepplewithe-Tray lamp. By a certain arrangement of ventilators and fans, the unexpected volume of gas can be speedily carried to the surface. Of course, there are careless men under the ground, just as there are above it. The imminence of danger is apt to make some of them reckless. In this way explosions occur and fatalities result; but in the Wyoming district, which yields a much larger portion of anthracite than either the Schuylkill or the Lehigh regions, accidents have been very rare during the past three years. The pay of the fire boss ranges from $60 to $100 a month.

Now we come to the miner as he is and not as he has been painted. The miner, if expert, is as much a skilled mechanic as any who works in a machine shop. If he be expert and understand his business, he will make good wages. He works just as long as he pleases; but is required to do a specific amount of work before he leaves. He is paid either so much per lineal yard or so much per wagon, and as the wagon varies in size, the price also varies. He is expected to mine each day as much as will keep the wagons busy. The coal must not contain a large proportion of slate. He is docked if there is too much slate in the wagons; because if the rocks attached to the coal should go through the rollers of the breakers above, they would cause great damage.

Eckley B. Coxe had at one time a Welsh preacher who also operated as a miner, and the latter was exceedingly careless as to the quantity of slate he would put into the wagons for coal. The mine boss expostulated with him time and again, but to no purpose. Finally, the boss went to Mr. Coxe and said that it was useless to try to dissuade the Welshman from his use of slate. Mr. Coxe had a talk with the preacher, and pointed to a large lump of coal and slate in the wagon through which ran, very palpably, a seam. Mr. Coxe asked if he thought that was according to Scripture to perpetrate such a fraud upon the mine owner. The preacher was ready in response and replied to his employer: "Sure the Good Book sayeth: 'Whom God had joined together let no man put asunder,' and surely you wouldn't ask me to violate such plain commandments;" but Mr. Coxe didn't see it in that light, and the Welshman was returned to his pastorate.

The miner goes to work at 7 o'clock in the morning, and as a rule is through his labors by 2 or 3 P. M. By that time he has cut enough coal to keep loaders and drivers busy until 6. In flat seams, such as prevail in the Wyoming region, the miner gets paid for mining and loading. On heavy pitches, such as exist in the Lehigh and Schuylkill regions, except in gangways, he gets paid simply for mining, while loaders are employed by the week and are paid separately. The mine helper delivers the coal to the driver. The other employes in the mine are the drivers, door boys, timber men and repair men, who are all paid by the day. Ten hours in each case is a day's work.

During the months of August, September and October the miners do not work full time, and these three months show, perhaps, a fair average of the miners' earnings throughout the whole year, after all charges for powder and other expenses have been deducted. Colonel Ezra H. Ripple, of the firm of William Connell & Co.—one of the largest coal operators in the anthracite regions—kindly permitted the writer, for the purpose of making an exact transcript from the books, to copy from the payroll of the Meadow Brook mine the wages of three representative miners working during the three months of the current year. During those three months the miners worked only seventeen and one-third days in each month. The wages of a poor worker were, during a little over one-half of each month, as follows: In August, $38.99; September, $32.74; October, $46.72—making a total sum received for 521 hours' work $118.45, or an average of about 23 cents an hour, or at the rate of $2.30 for a day of ten hours.

From this same payroll a good workman was shown to have received during the three months named, respectively, working the same number of hours, $46.39, $52.30, and $50.60, or a total of $149.29 for 521 hours' work. This is nearly 30 cents an hour, or at the rate of $3 for a day of ten hours. The same payroll for the same time showed an average worker making, respectively, $44.68, $45.37 and $50—a total of $140.05, or at the rate of $2.80 a day of ten hours. The pay of their laborers or helpers, whose work is principally to pick the coal or to lift it into the cars, and who are in every sense simple laborers, averaged during the 521 hours of three months $95 for the 521 hours' work, or over 16 cents an hour; or, for a day of ten hours, $1.60. These wages certainly compare favorably with those of laborers and mechanics in factories, and in many cases excel them. The writer was also permitted to make transcripts from the payroll of the William A. colliery at Duryea, for the same months. During August the miners worked thirteen days of 10 hours each, and the payroll showed that a poor worker received during August $34.06. In September the miners there worked thirteen days, of nine and a half hours each day, and received during that month $42.99. In October the miners worked fourteen days, of eight and a half hours each day, for which each received $45.75. The payroll showed that a good workman at that same colliery, working the same number of days and hours, received in August $62.70; in September, $54.61; and in October, $73.68. It should be stated that during some months the miners work continually, and sometimes earn for six or seven hours' work daily as much as $100 a month. The figures given above, however, are a fair average for the year, and show, without bias, the general earnings of the miner.

The interior of a mine consists generally of a main gangway, along which extends a railway track for the passage of cars which carry the coal to the surface, flanked on either side by "breasts," divided off so that each miner and his assistant are held responsible for them separately.

It happens sometimes after an explosion occurs, and the coal is thrown down, that there will remain among a miscellaneous lot of pieces of all sizes some big chunks of coal which require to be demolished by the pick and shovel. It is not practicable to dissever this further by powder, and therefore it has been disintegrated by the pick. After the coal has been thrown down and the smoke of the exploding gunpowder has been wafted away by the air fans, the work of loading the cars begins.

The coal is now taken to the surface by means of the cars, most of them being operated by steam power or by electricity. There is a whole system of turnouts within the mine known as "passing branches."

It was formerly the habit, in order to save time and in disregard for the miners' welfare, to make the roofs low so that some of those engaged in daily toil through incessant stooping became dwarfed, and many were unable to hold themselves erect. There are a few such low roofs now, but in nearly all the workings the miner is able to stand erect. A glance at the ordinary miner shows one an upright, healthy appearing person, although some of those who have become aged and were workers in the mines thirty or forty years ago, through stooping, occasioned by the old low roofs, are unable to stand up, and a fixed curvature of the spine has resulted. One such person—familiar to the citizens of Scranton—who was gone to his daily toil in the mines for the last forty years, is almost bent double; his body from the hips upward is almost horizontal. Although he is an object of pity and compassion to those who see him, a happier man does not exist, and his deformity, he declares, is entirely unfelt. He is an expert miner, however, and rarely has to work over six hours each day. He makes good wages and enjoys life more than the ordinary worker above ground.

After the coal has been scattered by the explosion and is ready for loading, large pieces of timber are placed under the wheels to prevent the cars from running away by reason of the weight within. This work of placing the wood beneath the wheels is technically known as "spragging."

There are two methods of ventilating in use, known as the open and the closed ventilators. One keeps a current of air continually in motion through the mines, and the other pumps the air in, to a large extent keeping it stationary, as in the atmosphere. There are varying opinions as to the relative merits of these two methods. One, however, is liable to give the miner cold if he is susceptible to draughts. By the closed ventilating method, there are various doors that are closed or opened according to the exigences and the air pressure. The processes of mining coal have undergone a revolution during the last twenty years. Steam and electricity, for the most part, do the work of hauling, which were formerly performed by mules, but for the purposes of drawing cars from gangway to gangway mules are still largely used in the mines. Like rats, they seem to thrive there. They grow fat and eat heartily, and not being overworked, become frisky and amuse themselves in their natural way of showing their heels on slight provocation. Some of these mules have never seen the daylight, being born in the mines.

They have stables built in the mines and are as tenderly cared for as if above ground. Speaking of rats, the miners cultivate their acquaintance and the rodents grow to a very large size, and being liberally fed by the miners, become as tame as ordinary cats. They are not vicious and become quite as playful as their feline enemies, sometimes following the miners, who take good care of them, like dogs, jumping up into their laps when meal time arrives and manifesting no hostile disposition whatever.

Neither the modern miner nor his helper has to perform very laborious work; not so much as a day laborer on a city's streets. The helper will ask the miner who is working on a breast how big a hole he will drill and in what locality. The miner points out the place and says for instance, "Well, drill a 15 inch hole." The helper does as he is told, at his leisure, and then inquires as to the size of the cartridge. The miner gives the information, saying, perhaps, "Five or six inches long." They sit down, deliberately make the cartridge, ignite the fuse and then remove to safe positions until the explosion occurs. Then the fans are set in motion and the smoke is carried to the surface. Meanwhile they will sit down and smoke their pipes and chat, and by the time the place is examined to see the result of the explosion it is probably 10 o'clock. Sometimes one shot will bring down several hundred wagon loads of coal, and, again, one may put in a shot and not get one-half a wagon load. As a rule, however, sufficient coal is broken so that the miner is not engaged over seven hours. He is charged for powder, and herein is exhibited the skill of the miner. One who has learned his business well will use a small amount to good advantage, and at the same time locate his drill so as to get the best results. If the miner is ill qualified for his work and does not understand his business, he is simply like any other poor workman, and receives proportionately less wages, but he gets all he deserves. It is the inefficiency of the poor worker that pulls down the general average. These latter are ganerally Poles and Hungarians and other ignorant immigrants, while intelligent Welsh or American miners command good wages for few hours' labor. They enjoy good health, take good care of their families and are so generally happy and contented with their lot that they wouldn't exchange their occupation for any on the earth's surface. The explosive most generally used in the Wyoming region is ordinary black gunpowder. In the

gaseous mines of the Schuylkill region different grades of dynamite are employed. They are undesirable, because they shatter the coal and the surrounding roof and pillars to an unforeseen and often unsafe degree.

Some jolly scenes are enacted in the mines. In one colliery, about three miles from Scranton, there exists among the miners a glee club, and a brass band has recently been formed. A happier set of men cannot be found anywhere than are those who have been made so by the beneficial effects of wise legislation and modern improvements generously introduced by humane operators.

A NEW MECHANICAL FLUID.*

By CHARLES WALLACE HUNT.

A HYDRAULIC piston for adjusting journal boxes to take up the wear from use would have the desirable features of delicacy of adjustment and ample rigidity for any strain which it would be called upon to sustain. The cost of the accurate construction needed, and the probable leakage of the fluid, would usually prevent serious consideration of this method. In canvassing the various methods of adjustment which could be used in the bearings of the connecting rods of our steam engines, the advantages and faults of this method were carefully investigated. The inevitable leakage of the liquid presented an almost unsurmountable barrier to its use.

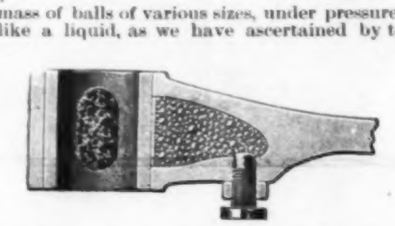
By making a wide departure from our ordinary conceptions in molecular physics, we can imagine a liquid composed of atoms as large as bicycle bearing balls. The anticipated trouble from the leakage of the fluid would then disappear as a factor in the ordinary mechanical fitting in steam engine work.

If the balls of this hypothetical fluid vary in size, their mutual pressures may be supposed to balance each other. If the balls were infinite in number, and the size limited, but with an infinite number of variations of diameter within the limits, the various local pressures would be balanced, and the mass would have the mobile property of a liquid.

Under compression each ball of a mass of various sizes would have the resultant of all the pressures on it at its center, and consequently would be in a position of equilibrium; but should the inclosing envelope change in form or capacity, a change in the direction of the pressures would take place; first, in the balls nearest to the movement, then in the adjoining ones, the balls severally moving in the direction of least resistance, until the resultant of the pressures again came in the center of each ball.

If the mass of balls were all of one size, they would interlock. This rigidity resembles the property of a solid.

A mass of balls of various sizes, under pressure, does act like a liquid, as we have ascertained by testing



in various ways. (On the table, at the reading of the paper, was shown a connecting rod of full size fitted up to be adjusted in this manner, just as it is used in practice, and also a model with a glass front and a spring piston, which permits the individual motion of the steel balls to be seen when the adjusting screw is turned. The mass is kept mobile by putting sufficient pressure on the movable piston.)

The accompanying cut shows a section of a solid-end connecting rod, having an annular brass bushing with an opening, in order that adjustment for wear can be made. One side of the bushing is held in place and adjusted by the pressure of a mass of hardened steel balls, varying in diameter from $\frac{1}{8}$ to $\frac{1}{4}$ in. Between the bushing and the balls is a thin plate of hardened steel to prevent the balls from indenting the softer metal. The adjustment for wear is made by forcing the mass of balls forward with a hardened steel adjusting screw.

When the wear has become so great that the range of the adjusting screw has been exhausted, a few more balls are inserted under the point of the screw, and an adjustment of the bearing is made as before. On the crank end of the rod the adjusting screw is on top, but on the crosshead end it is on the front side, clear of the crosshead, where the adjustment is as conveniently made as it is on the crank end.

We have been running last year 40 bearings of this type in various places, in the East and in the West, working with steam boiler pressures of from 80 to 160 lb., giving pressures per square inch of projected area of the pins ranging from 600 to 1,000 lb. The pressure on the balls per square inch is about 50 per cent. greater. If we assume that the balls are about $\frac{1}{8}$ in. diameter, and that 60 balls are in contact with the bushing on each square inch, the pressure sustained by each ball would be from 15 to 25 lb. Assuming that the elastic limit of the steel in the connecting rod shown is 30,500 lb. per square inch, and that the hardened steel balls have a pressure of 25 lb. on each one, we would expect that each ball would embed itself in the steel envelope until the area sustaining the pressure was strained to the elastic limit. This area would be 1-1270 square inch for each ball, which is almost exactly equal to the area of a circle 1-100 inch in diameter.

At first the bearings require frequent adjustment, but the balls soon get in a fixed position, and then they need adjustment for the wear of the bushing only. The adjustment of these bearings is apparently as delicate and positive as though a liquid were used. In cases where the adjusting screw was purposely made to turn freely, the adjustment could easily be made by the thumb and fingers, and if care were not used, too great a pressure on the pin would result.

The connecting rod shown is for a 10 in. diameter cylinder steam engine and is a steel casting, made by I. G. Johnson & Co., fitted with an adjusting screw having 14 threads per inch, and a pressure area of balls on the bushing 18 times the area of the screw. If the screw is turned with a force of 25 lb. on an 8 inch wrench, the friction of the screw absorbing 25 per cent. of the force, the pressure on the bushing would be over 30 tons. While this pressure might be used in other applications of this novel fluid that have been proposed, it was clearly out of place in connecting rod bearings, and we now make the head of the adjusting screw of such a form that an ordinary wrench cannot be used, and the adjustment is made only by a spanner which will, by its peculiarity, remind the engineer that care is necessary in the adjustment.

* Abstract from a paper read at the Montreal meeting of the American Society of Mechanical Engineers.

PHOTO-ENGRAVING ON GLASS.

By P. C. DUCHOCHOIS.

THE most simple process to engrave on glass by the intervention of photography, that which will first be selected by the amateur, is the following:

A glass plate is carefully cleaned by immersing it in a solution of potassa, then, after rinsing in nitric acid, diluted with an equal volume of water for the same period. The plate is afterward washed by rubbing with a rag, rinsed again, and when drained, but still damp, flowed twice in opposite directions with

Albumen	4 ounces
Aqueous ammonia	1 drachm
India ink	1 "
Ammonia bichromate dissolved in 1 ounce of water	50 grains

Beat the whole into a thick froth, let settle, and decant the clear liquid for use; it will keep for two or three weeks.

The film should not be dried by resting the plate upright; it would be too thin. It should be equalized by inclining the plate in all directions after draining, then allowed to dry in a horizontal position, either spontaneously or in an oven moderately heated, in order not to insolubilize the albumen. Large plates are best coated by means of the turning table at very slow speed.

The plate is exposed under a diapositive in line, quite intense, for a period of from four to five minutes in the sun, or from twenty to twenty-five minutes in the shade, which is advised if the negative is not sufficiently intense.

After exposure, the parts of the albumen film—the lines of the image—not having been acted on by light, remain soluble, while the others, which have been insolubilized by its agency, form the ground, and, after development, the reserves—that is, the parts protecting the glass plate from the action of the etching fluid.

To develop, or in other words, to dissolve the soluble parts, the plate is immersed for ten minutes in cold water twice renewed, then lightly rubbed with a soft rag or a camel's hair brush under a thin layer of water, and, when the lines are clear from albumen, thoroughly rinsed and afterward set aside to dry spontaneously. The plate is then ready for etching. For this purpose a rim is made around the edges of the plate with banking wax, a mixture by equal weights of paraffine and vaseline, and flowed with an etching fluid consisting of

Sodium fluoride	3 drachms
Water	3 ounces
Alcohol	1 ounce
Acetic acid	1 drachm

In a few minutes the design is engraved. This done, the etching fluid is poured off in a gutta percha vial for future use, the banking wax removed, the plate rinsed and immersed in the solution of potash to dissolve the albumen, when, after cleaning and rinsing, the design stands mat on the clear glass.

By exposing the plate under a negative in line, the design is transparent on the mat surface of the glass.

To engrave by the fumes of hydrofluoric acid, a leaden tray about four inches deep, provided, for the different sizes of plates, with kits thickly coated with paraffine, is placed on a sand bath moderately heated, and, having poured one part of very finely powdered fluorspar, mixed by means of a spatula, with two parts of sulphuric acid at 66 Baume, the plate is placed face downward over it. The fumes which are evolved condense upon the design, attack the glass and sufficiently etch it in a few minutes.

The glass is not deeply etched by the processes above described, but that is not necessary, for a superficial biting-in always produces enough accentuated contrasts between the mat and clear parts of the design to produce the desired effect.

This method of etching gives excellent results, but the image is still sharper by submitting the plate to the fumes of concentrated hydrofluoric acid without heating it.

Albumen does not form a very resisting reserve to prevent the glass from being attacked by the acid fluoride of sodium solution or the fumes of hydrofluoric acid and failures sometimes result therefrom if the coating is too thin or the albumen too fluid. A perfect reserve is obtained by one of the following processes:

First Process.—Coat the plate by means of the turning table with

Bitumen of Judæa	75 grains
Turpentine, anhydrous	3 ounces
Benzole, "	4 drachms

When the film is dry, which requires about twenty minutes, expose under an intense diapositive in lines for a period of from twenty to thirty minutes in the sun, or from one and a half to two hours in the shade. Light insolubilizes bitumen. To develop, the plate is immersed in turpentine oil and gently rubbed with a camel's hair brush. The image appears rapidly, and, if the exposure time has sufficiently lengthened to insolubilize the bitumen film through in the parts acted on, there is no danger of washing out the lines. When the latter stand clear the plate is at once washed under the tap, then gently rubbed with soap water to remove any adherent bitumen from the lines, and finally well rinsed and allowed to dry spontaneously in a strong light, after which the design can be etched by any one of the methods described.

Second Process.—The drawback in the above process is the long exposure necessary to insolubilize the bitumen. This is quite serious in dull weather, since the exposure time should, in this case, be lengthened for many hours. But if the plate prepared with bitumen is afterward coated with bichromated albumen, the exposure is reduced to a few minutes in the shade, for it suffices then to impress the albumen film without regard to the bitumen, which does not play any other part in the process but to form a good resist under the albumen.

Bitumen of Judæa	24 grains
Paraffine	5 grains
Turpentine, anhydrous	1 ounce

To develop, the plate is soaked for ten minutes in cold water, whereby the albumen not acted on is softened, then washed off under the tap, leaving behind the under film of bitumen which forms the image. When dry, the plate is gently rubbed with a rag and turpentine, and as soon as the bitumen not protected by the insolubilized albumen is softened and dissolves, the plate is placed under the tap or a strong jet of water, which completes the development. It now suffices to dry the plate and afterward to etch it in the ordinary manner.

This process is recommended when the design is fine. However, a cliche in half tone, *grained* by means of a ruled screen—Berchtol's method—is best reproduced by simply preparing the plate with albumen.

As has been explained above, the exposure time should be much lengthened. Twenty minutes is a minimum in sunshine to insolubilize *through* the parts acted on, which is a *sine qua non* of success. The development is made as usual—with turpentine oil—and the plate etched by the acid fumes, or the solution of sodium fluoride acidified with acetic acid.—*Photographic Times.*

CRYSTALLINE GLASS.

By NICHOLAUS T. NELSSON.

FEW trade secrets have been kept so well from the knowledge of the general public as the process of producing the above mentioned species of decorative glass. It is said to be the invention of a French engineer, who called it "verre gievre," or frozen glass. In the United States, where its manufacture has been brought to a much greater state of perfection than in any other country, it is known under the more common names of chipped or crystalline glass, and the operation of manufacture "glass chipping." It has a remarkable appearance, being covered with fern-like figures, no two of which exactly resemble each other, differing in both shape and form. To those unacquainted with the method of producing this glass—and there are very few that have any conception of how it is made—the process of manufacturing is very puzzling.

This method of ornamenting glass is so simple that most people, when they have it first explained to them, will hardly believe that such simple means can produce such marvelous results. It is done by covering glass with glue, which adheres to the glass, and when the glue dries it shrinks and draws with it pieces of the glass or chips of glass.

The first necessity in carrying out this process is to have the glass which is to be ornamented ground either by means of the sand blast or by the more troublesome means of grinding by hand. This is done by rubbing a stone with a flat side over the glass till it has lost its polish and become translucent. A thin layer of emery kept wet with water will facilitate the grinding, which should be as coarse as possible, and for which reason grinding done by the sand blast is preferable.

After the glass has been ground it should be kept scrupulously clean. Great care should be exercised that the surface is not touched by the hands. Any trace of grease is very apt to make the results uncertain. If the glass has, however, become contaminated it may be cleaned with very strong ammonia, although glass which it has been necessary to clean is apt to be rather unreliable.

When everything is ready the glass is placed in a room where it is intended to carry on the process, accurately leveled, and flowed with a solution made as follows:

Good glue is placed in sufficient water to cover it and allowed to soak for twenty-four hours. If the water is absorbed during the soaking, more may be added. It is then liquefied over a bath and is then ready to use.

In practice it makes considerable difference which kind of glue is used. By repeated experiments it has been found that Irish glue is the best for the purpose.

A wide brush is dipped in the glue and applied to the glass. The coating should be a thick one, otherwise it will not be strong enough to do the work required. When the plates are coated they may be placed in racks, and the temperature of the room raised to 95° or 100° F. They are permitted to remain at this temperature till they are perfectly dry, which will be in from ten to twenty hours.

It is at this stage that the uncertain character of glue shows itself. Under certain circumstances the glue will begin to crack and rise of itself without any more manipulations, but most generally it will require to have a stream of cold air suddenly strike it. If the plate is perfectly dry at this period, and of sufficient thickness, the top surface of the glass will be torn off with a noise resembling the crack of a toy pistol. Sometimes the pieces of glue will leap two or three inches into the air, and may even fly into the eyes and injure them. To guard against this it is customary for the workmen to wear a pair of spectacles fitted with plain glass. The glue will come off sometimes at the least expected times, notably if the plate with dried glue is being carried from one room to another. Plates which have shown a decided disinclination to chip have manifested a remarkable and unexpected activity and have jumped into the face of the person carrying them in such a manner as to cause him to drop them.

The strength of the glue is something very extraordinary. If the glass has been coated on the hollow or belly side of the glass, the slight leverage thus obtained is almost sure to break it, especially if the glass be single strength. Even plate glass is not unfrequently broken. It might be a rather interesting mathematical calculation to find out the force necessary to separate the surface of glass in this manner on a piece say 48 by 48 inches.

The result of the operation described may be vari-

ous. It may be either a design resembling ferns of various shapes and sizes, or it may be a circular design exhibiting narrow, feathery appearances or, if unsuitable glue has been used, it may be of a nondescript appearance.

If, after the glue has been applied but before it has become any more than set, a piece of stout paper is pressed over it and it is allowed to dry in this way, the glass will have less the appearance of feathers, but will be much coarser and larger pieces will be removed.

The circular design mentioned occurs under the same circumstances as the other, with the exception that it generally is made during cold weather. Sometimes several weeks may run along and nothing but this formation be made.

Some very elegant designs may be produced by submitting the glass once more to the same operation, covering it as before and allowing the glue to chip. This is known by the name of double chip. If the glass was covered with the small circles in the first place, the second time it will have an appearance very much resembling shells, and for this reason this has been called shell chip.

If, instead of using ordinary glass, colored glass is employed, pretty and original effects may be obtained. The glass may be either colored clear through or it may have only a thin coating on one side. In the latter case in some places the entire layer of colored glass will be removed, and in other places only a very little, and will therefore give all the gradations between those two extremes.

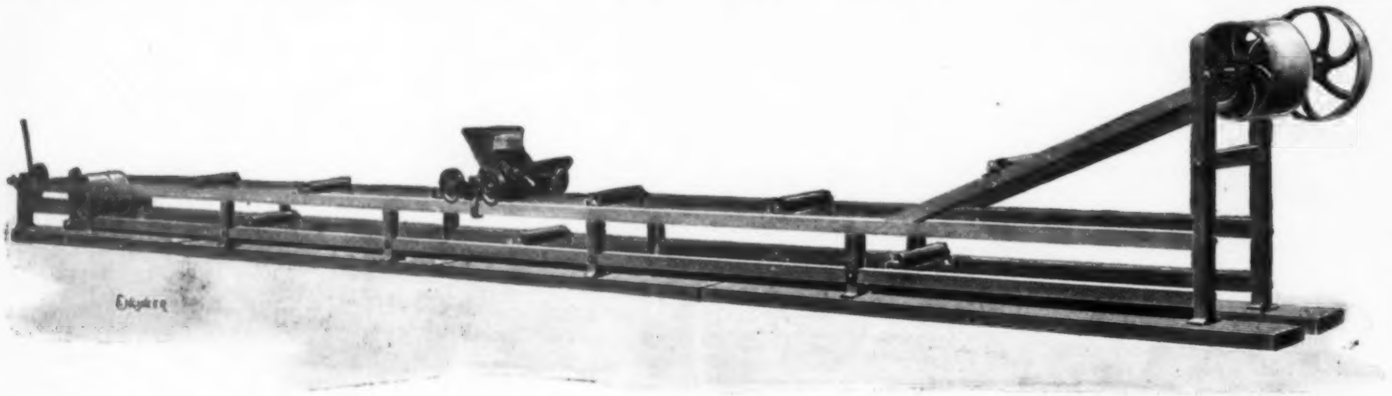
Glass which has been treated in this way may be silvered and gilded and thereby be made still more remarkable in appearance.

Extremely elegant effects may be obtained by what is known as "chipping to a line." The design is ground in the glass by the ordinary sand blast process. After the glass has passed through the machine, the protective coating (wax is generally used) is not removed, but is left on to keep the glue off those parts which are not intended to chip. The glue is then applied in a thick layer to the ground portion and the process is carried on as usual.

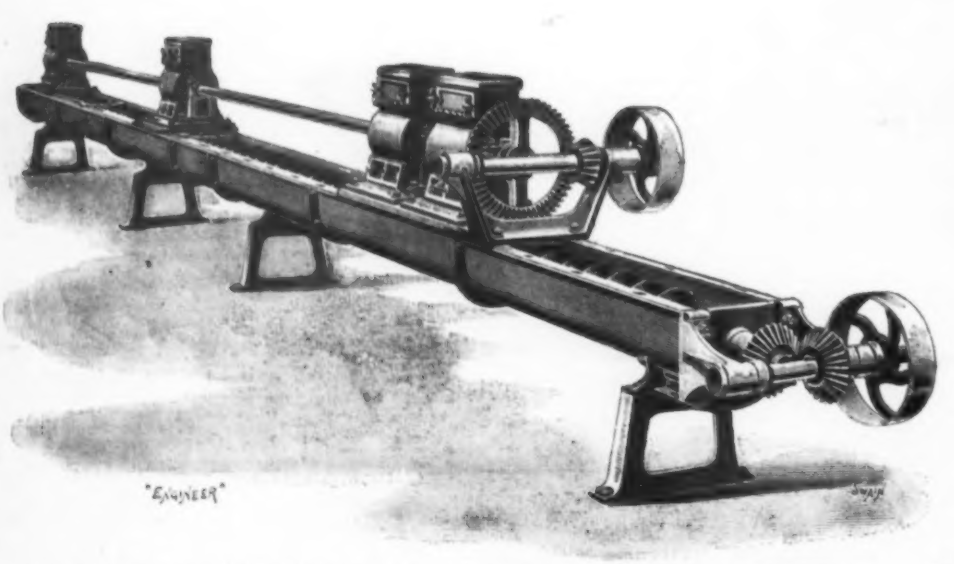
VINES ON WALLS.—In a recent official report it is asserted that the common notion that vines covering walls tend to produce or promote dampness is so far from being true that the contrary is the case, such covered walls being drier than those exposed. A moment's reflection would suggest that a thicket of leaves acts as a thatch, throwing off rain and keeping walls dry. They also have the further effect of preventing walls from being heated by the sun.

ELEVATORS AND MACHINERY—FLOUR MILLS, BROMLEY.

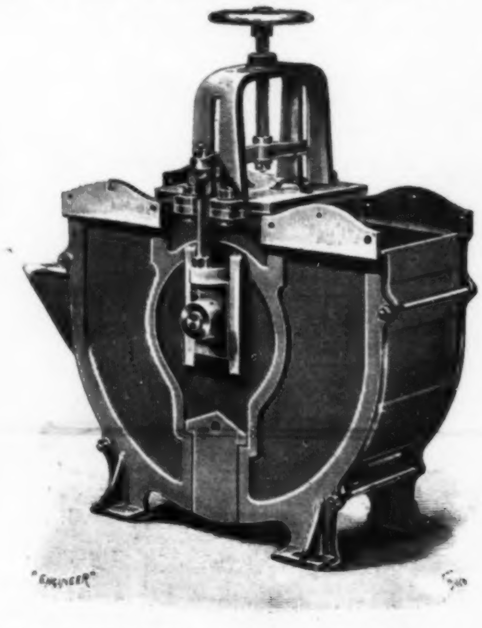
THE installation of machinery which we describe is from the Sun Flour Mills, Bromley, England, illustrated in a recent number of *The Engineer*, London, to which we are indebted for our engravings and the following particulars. The mechanism consists of elevators, cleaning machinery, worms, conveyors, and silos required to receive and discharge wheat from any vessel, and after giving the wheat a preliminary course of cleaning, to deposit each class of wheat in separate bins or silos, afterward mix them in any required proportion together, and finally allow them to lie together, blend and assimilate.



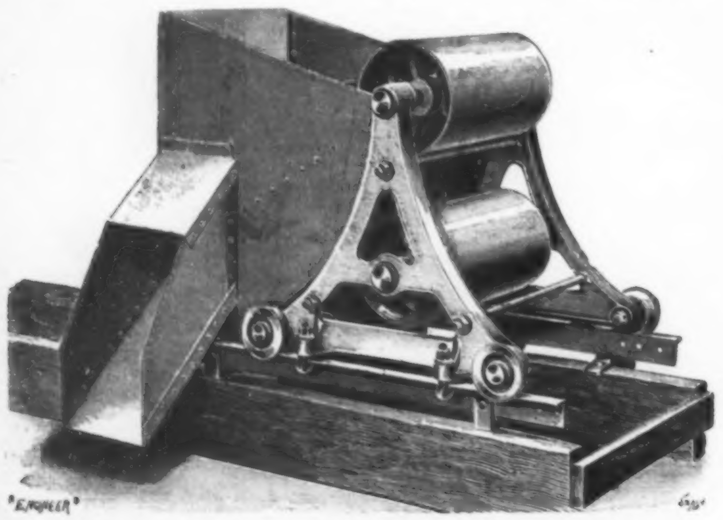
BAND CONVEYOR—GROUND FLOOR—FRAME, CARRYING AND TERMINAL ROLLERS, AND MOVABLE DISTRIBUTING HOPPER.



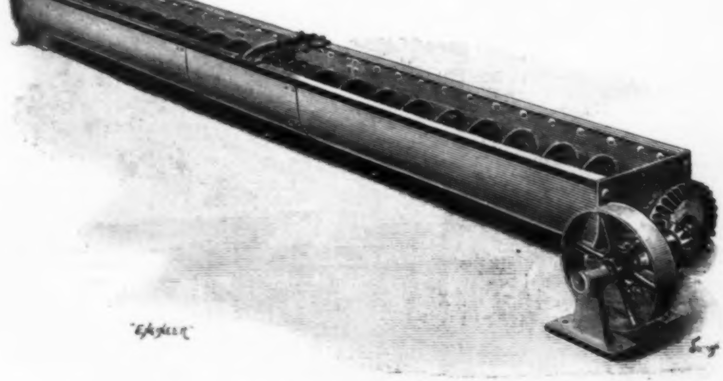
WORM WHEAT CONVEYORS WITH MEASURERS AND MIXERS ATTACHED.



ELEVATOR BOTTOM WITH TIGHTENING GEAR.



DISTRIBUTING HOPPER OF UPPER CONVEYOR BAND.



SPIRAL WORM CONVEYOR.

GRAIN ELEVATING AND DISTRIBUTING PLANT.

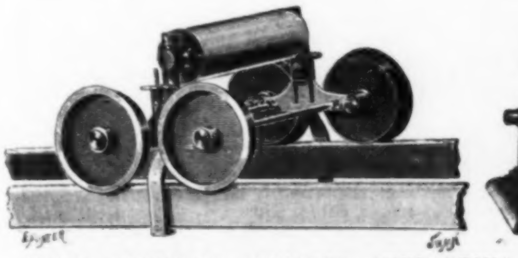
The wheat, after being lifted out of the vessel by the elevator, is spouted from the said elevator into the cleaning department; it then falls into another large elevator, which raises it into the first set of scales, where the wheat is weighed; thence it falls into two large double sieve warehouse separator cleaning machines, of which we give an engraving herewith. The wheat is first subjected to a powerful exhaust before passing on to the top sieve, which is usually clothed very coarsely to allow all the wheat to be sifted through, the large impurities tailing over. The wheat after passing through the top sieve is de-

livered on to the bottom sieve; this sieve is clothed very finely, so as to allow only such small impurities as dust, sand, small seeds, etc., to pass through, the wheat tailing over. As the wheat leaves the sieve it again meets with a powerful aspirator draught, which removes all dust and light impurities which may be present. The heavier impurities lifted out by the exhaust are deposited in the aspirating chambers. After leaving the cleaning machines the wheat falls into another elevator, which delivers it into the second building, which contains the silos, marked D on the plans; here it falls into an elevator extending the full height of the building, and is lifted up to a band conveyor which is fitted with movable distributing hopper and telescopic spout, as seen in the engravings, so that the wheat can be delivered from this band conveyor into any one of the first set of bins, which may be called "storage bins." Underneath these storage bins is fixed another large band conveyor which has a capacity of 25 tons per hour, with movable hopper, so that the wheat can be discharged from any one of these bins on to the rubber band. This band delivers the wheat into another large elevator, which elevates the wheat on to another band conveyor with telescopic spout, which delivers the wheat into any one of fourteen mixing bins, different qualities of the wheat being delivered to the different mixing bins. Under each of these mixing bins are fitted automatic wheat mixers, seen in the longitudinal section, and on this page. These mixers are fixed on the top of a wheat worm, and can be adjusted to allow the wheat to pass out of the mixing bins in any required quantity. The mixture of wheat required for milling purposes can be thus arranged to suit the requirements of the trade.

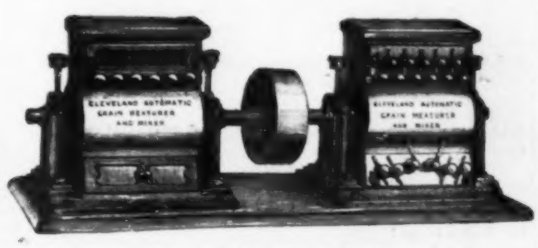
The mixing worm delivers the wheat into another large elevator, where the wheat is lifted up into a worm which runs the full length of a third set of bins, called blending bins; this worm is provided with separate

able chain having steel buckets secured thereon at regular distances apart, and working over special tooth sprocket wheels. The elevator trunk or leg has a substantial wrought iron framing built up of angle and T iron, and fitted with the necessary cross and diagonal stays firmly braced together, the whole being lined on sides with timber, and provided with wood covers front and back. All the bearings in this elevator are of malleable iron, bushed with gun metal, and all the internal shafts are of Bessemer steel. Tension gear is provided at the head of the elevator for taking up the slack in the chains, and is arranged so that the tension screws can be actuated simultaneously. Greenheart guides are fixed inside the trunk for guiding the chains and buckets, both in the upward and downward course. The mouthpiece of the elevator, through which the long leg of trunk slides, is carried upon wrought iron girders of suitable section, fixed on the girders of the overhanging portion of the tower. A grate, constructed of taper steel bars, is fixed to the foot of the elevator, and the head is provided with lifting straps for the raising and lowering of the elevator.

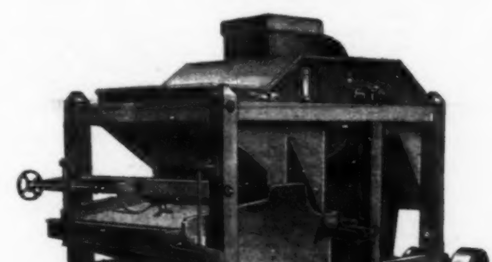
A special crab, belt driven, with stopping and starting gear, is provided for raising and lowering the elevator by means of wire ropes, and the requisite gear is indicated in the space marked A.



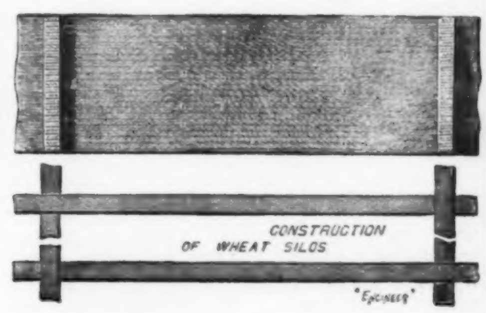
BAND CONVEYOR—MOVABLE SUPPORTING ROLLER.



GRAIN MEASURING AND MIXING MACHINE.



WAREHOUSE SEPARATOR CLEANING MACHINE.



outlets and slides for feeding any one of these blending bins. Another large worm is fixed under these blending bins, so that when the wheat has lain in them for a sufficient time to allow the different qualities of wheat to assimilate, the wheat is allowed to pass into the worm, and after being again weighed, is passed by means of a large wheat worm and elevator into the mill proper.

Silos.—These are constructed of flat pieces of wood 5 in. by 1½ in. at the bottom and 3 in. by 1½ in. at the top, nailed flat and overlapping one another, as in the annexed engraving. The wood walls of the silos are thus built up of a very large number of boards, forming, when nailed together, great slabs of wood of enormous strength. The difficulties which used to be experienced in obtaining sufficient strength for grain bins are thus surmounted. The mouthpieces consist of cast iron hoppers, supported in and resting on girders supported by cross girders and substantial pillars standing on concrete. They are thirty-three in number, 36 ft. deep, 9 ft. square, and are divided as follows: Twelve for storage purposes, fourteen for mixing, and six for blending. One bin is reserved for English wheat, which is of course delivered direct into the mill, and not from barges. Also the contents of each separate bin can be conveyed on to a pair of scales, and after being weighed returned to the bin, this being used for stock taking purposes.

The barge elevator is about 36 ft. high between centers, and is capable of discharging wheat at the rate of 40 tons per hour. It is constructed by Messrs. Thos. Robinson & Sons, Rochdale, by whom also the whole of the plant we are describing has been designed and manufactured. The barge elevator is so arranged that the delivery of the grain from the elevator is always at one fixed point, namely, at A, where the elevator cup chain passes over a deflecting roller, so that the grain is tipped into the hopper, from which it runs down to the foot of the elevator as in the transverse section. It is fitted internally with two strands of strong detach-

RUSSIAN SHEET IRON.

THE inquiries we receive from time to time respecting Russian sheet iron demonstrate that there is a demand for that article which is badly supplied, as well as a good deal of ignorance respecting the method of its production. It is generally supposed that the mode of manufacture is a dark secret, which cannot be penetrated—indeed, quite recently, a newspaper paragraph has been in circulation in which it is asserted that Russian sheet iron is produced in a huge walled town, from which no workmen is ever allowed to depart alive. This statement is an absurdity on the face of it. As a matter of fact, there is no particular secret in the matter, seeing that Dr. Percy described the process a great many years ago, and quite recently Mr. F. L. Garrison has contributed a paper on the subject to the United States Association of Charcoal Iron Workers. Mr. Garrison visited the works in the Ural district of Russia and saw the sheet iron made; consequently his paper possesses unusual value and interest to all producers and users of fine sheet iron.

The ores used are chiefly those from the Maloblagodatj mines, the chemical composition being: Metallic iron, 60 per cent.; silica, 5 per cent.; and phosphorus, 0·15 to 0·06 per cent. The ore is either made into malleable iron in various kinds of bloomaries or is smelted into charcoal pig iron, and then puddled or dealt with in a Franche-Comte hearth. The blooms or billets are rolled into bars 6 inches wide, ¼ inch thick and 30 inches long. The bars are first assorted, and the inferior ones rerolled. Those accepted are carefully heated to redness, and cross rolled into sheets about 30 inches square, the process necessitating from 8 to 10 passes through the rolls. The sheets thus obtained are again twice heated to redness, and rolled in sets of three each, great care being taken that every sheet before being passed through the rolls is brushed over with a wet broom made of fir, and at the same time powdered charcoal is dexterously sprinkled between the sheets. The sheets receive ten passes through the rolls, and are then trimmed to a standard size of 25 by 56 inches. They are then further assorted, the defective ones being thrown out, each sheet is wetted with water, dusted with charcoal powder, and dried.

That done, they are made up into packets containing 60 to 100 sheets, and bound up by the wasters. The processes of annealing and finishing are thus described by Mr. Garrison:

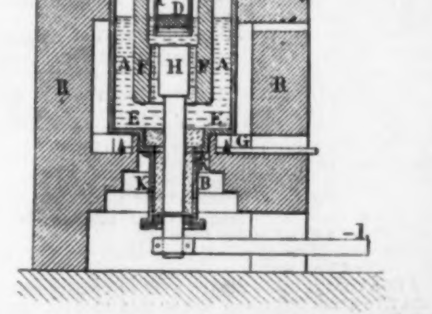
"The packets are placed, one at a time, with a log of wood at each of the four sides, in a nearly air-tight chamber, and carefully annealed for five or six hours. When this has been completed, the packet is removed and hammered with a trip hammer, weighing about a ton, the area of its striking surface being about 6 by 14 inches. The face of the hammer is made of this somewhat unusual shape in order to secure a wavy appearance on the surface of the packet. After the packet has received ninety blows equally distributed over its surface it is reheated, and the hammering repeated in the same manner. Some time after the first hammering the packet is broken and the sheets wetted with a mop to harden the surface. After the second hammering the packet is broken, the sheets examined to ascertain if any are welded together, and completely finished cold sheets are placed alternately between those of the packet, thus making a large packet of from 140 to 200 sheets. It is supposed that the interposition of these cold sheets produces the peculiar greenish color that the finished sheets possess on cooling. This large packet is then given what is known as the finishing or polishing hammering. For this purpose the trip hammer used has a larger face than the others, having an area about 17 by 21 inches. When the hammering has been properly done, the packet has received sixty blows equally distributed, and the sheets should have a perfectly smooth, mirror-like surface.

"The packet is now broken before cooling, each sheet cleaned with a wet fir broom to remove the remaining charcoal powder, carefully inspected, and the good sheets stood on their edges in vertical racks to cool. These sheets are trimmed to regulation size (28 by 56 inches), and assorted into Nos. 1, 2, 3, according to their appearance, and again assorted according to weight, which varies from 10 to 12 pounds per sheet. The quality varies according to color and freedom from flaws or spots. A first-class sheet must be without the slightest flaw, and have a peculiar metallic gray color, and on bending a number of times with the fingers, very little or no scale is separated, as in the case of ordinary sheet iron."

It is the peculiar feature of Russian sheet iron to possess a beautifully polished coating of oxides—what the Germans term "glanz"—and it is in securing that finish that the makers and workmen excel. The trade has been in the same hands for a very long series of years, and the men naturally possess the accumulated skill of generations of their predecessors. It must be remembered, also, that the iron ores used are very pure, containing but small traces of phosphorus and no sulphur, and that they are smelted and the product heated exclusively with wood fuel. It is not very easy to understand the exact effect of the powdered charcoal, nor the effects of the interposition of the cold finished sheets between those not yet cold. Mr. Garrison says that the Russian ironmasters attribute the excellence of their product to these peculiarities of treatment, and he seems convinced that there is no secret about the process. If he is right, then it would seem to follow that there ought to be no special difficulty—given similar materials and fuel, and with the same methods of procedure—in turning out sheet iron as good as the Russian article in this or any other country. In view of the demand for Russian sheet iron, it might pay some of our sheet rollers to make the experiment, at all events.—*The Ironmonger* (*London*).

IMPROVEMENT IN THE MANUFACTURE OF SODIUM AND POTASSIUM.

THE caustic soda or potassa, liquefied at as low a temperature as possible, is decomposed in the Castner process by an electric current. When the temperature



APPARATUS FOR THE PRODUCTION OF CAUSTIC SODIUM AND POTASSIUM.

is elevated, the power of the bath for the absorption of the metal and the oxygen becomes considerable, and, practically, no decomposition occurs. Consequently the material should not be heated to a temperature greater than 20 degrees above its melting point, and, at the same time, it is necessary to have prompt means at one's disposal for the rapid separation of the metal from the bath.

The apparatus consists of an iron vessel, A, set in brick masonry, R, and in which the caustic soda or potash is melted by the action of the heat obtained from a gas burner, G. The vessel is provided with one or more conduits, B, adapted for the reception of the negative electrode of metal, the space, K, being filled in with the melted alkali, which becomes resistant and holds the electrode, H, in position.

A tubular iron reservoir, C, provided with a cover, N, and a cylinder of wire gauze, D, fixed to the lower extremity, is suspended above the electrode. This wire gauze, which surrounds H, remains between the latter and the positive electrode, F.

At P there is an aperture for the escape of the gas and the introduction of a thermometer. S is an insulant of asbestos or other material. The current is furnished by I and L.

The dimensions of the electrodes and their distance should be proportioned to the quantity of the current. If the electrodes were larger than was strictly necessary, the elements would be apt to be absorbed by the

bath and to recombine with a useless expenditure of energy. On the other hand, if they were too small, the resistance would increase and the bath would become superheated exactly at the part where an elevated temperature is most prejudicial.

When the decomposition takes place, the free metal rises and floats upon the surface of the caustic, C, whence it is removed by means of an apparatus in the form of a spoon, which is very finely perforated, so as to permit the caustic alkali to flow out and the metal to remain.

Caustic soda or potash, as the case may be, is added to the bath from time to time, so that the operation may not be submitted to any interruption.—*Le Genie Civil.*

MATHEMATICAL TABLES.

By M. JOSEPH DE PEROTT.

IT frequently happens that persons living far apart, and having no communication with one another, have to perform similar calculations. The idea arises naturally that somebody would perform such calculations once for all and publish the results, so as to be accessible to anybody who wants them. Books which contain such ready-made calculations are called tables.

A great many tables have been, in fact, published, but with the exception of logarithms, taught everywhere, they are very little known. My object is to call attention to such tables, confining myself, however, to those of the most elementary kind. As some of the tables are very scarce, I shall mention public libraries where copies of them can be found.

Some two years ago I delivered a course of lectures on numerical computation in Clark University, and I was pleased to find in the public library at Worcester an excellent collection of tables, which, indeed, I deem to be the best in this country.

One of the most useful tables is a table of squares. Such a table going as far as the square of ten thousand will be found in Barlow's tables, but the largest in existence is Ludolff's, which goes up to the square of one hundred thousand. The book—a very scarce one by the bye—is a clearly printed volume measuring seven and three quarters inches by six and a quarter in the cover, and containing four hundred and sixteen pages, exclusive of the introduction, so that, if reprinted, it need not cost more than two dollars.

The title of the work, published at Erfurt in 1689, is "Tetragonometria Tabularia."

How to find the square of any number containing not more than five figures by means of such a table hardly needs an explanation. So that if the square of 89437 is desired, one has only to look at the corresponding place in the table, to find 7998976969 as the result, which saves the trouble of multiplying 89437 by itself.

I shall dwell a little more on the use to be made of such a table in extracting square roots.

First case. We have a whole number of nine or ten figures to deal with.

In such case one has only to look for the nearest approach to the number among the squares in the table, then the number whose square affords the nearest approach will give five figures of the root with an error of less than half a unit.

Example: To obtain the square root of 7834921985. By looking in the table it will be found that the square

$$7834905225 = 88515^2$$

is the nearest approach to the number given, so that 88515 gives five figures of the root with an error of less than half a unit.

Second case. If the whole number contained in the given number has not nine or ten figures, it is only necessary to multiply the given number by a power of 100 or $\frac{1}{100}$ sufficient to make it contain nine or ten figures in the integer part.

Example: Suppose the square root of

$$273,45921478$$

is desired.

By multiplying it by 100^3 we obtain

$$273459214,178,$$

which, in fact, has nine figures in the integer part, and by looking in the table we find

$$273472369 = 16537^2$$

as the nearest approach, so that 16537 is the desired root with an error of less than $\frac{1}{2000}$.

The table gives at sight, accordingly, five figures of the root of any number whatever.

I find that it takes me from six to twenty seconds to find five exact figures of the square root of any number by means of Ludolff's table.

Only one modern table of squares of a similar extent has been published. The title is Kulik, "Tafeln der Quadrat- und Kubik-Zahlen" (Leipzig, 1848). This table contains cubes besides squares, so that by means of it five figures of the cube root of any number can be found at sight.

The operations of addition and subtraction are so easy that there is little need of help while performing them. If such help is needed, however, I would recommend to use the Chinese swan pan, which can be seen in any laundry and may be easily bought for a dollar. A complete description of the instrument in English will be found in Dr. Knott's paper in the volume xiv. of the Transactions of the Asiatic Society of Japan, a copy of which is in the library of the Oriental Society in New Haven.

As a product depends on two numbers, the multiplicand and the multiplier, the results of multiplication are not so easy to tabulate as the squares which depend only on one number.

The largest table of multiplication in existence goes, in fact, only so far as the product of 999 by 999. I mean Crelle's "Rechentafel" (Worcester public library). The product of three figures by three can be taken at sight from such a table, and the finding of products of much larger numbers is greatly facilitated by its use. It affords still greater help for performing divisions.

Tables for performing multiplications have been also constructed on quite a different principle, known already to the Arabs, viz., the product of two numbers is equal to the difference between the quarter-square of their sum and the quarter-square of their difference.

The largest table of quarter-squares in existence is Blater's (London, 1888), a copy of which can be found at the Worcester public library. By means of this table the product of two five-figure numbers can be obtained with very little labor. Suppose you want the product of 98497 by 89786, the operations would then be

$$\begin{array}{rr} 98497 & \\ 89786 & \\ \hline 188283 & 8862622022 \\ 8711 & 18970380 \\ \hline & 8843651642 \end{array}$$

The two numbers below the given numbers are obtained by adding and subtracting them, then the corresponding quarter-squares are taken from the table, and their difference gives the result. A complete description of the table is to be found in Mr. Glaisher's article in *Nature*, vol. xl., p. 573.

A high theoretical interest centers around the so-called factor tables, which give the decomposition of any given number within the limits of the tables into prime factors.

It frequently happens in the theory of numbers that the knowledge of the factors of a number is required, and it will take, I think, about an hour on an average to perform the decomposition of a seven-figure number not divisible by a small prime. Factor tables going as far as nine millions have been constructed, by Burckhardt for the first three millions (Paris, 1814-17), by Mr. Glaisher* for the next three (London, 1879-83) and by Dase for the last three (Hamburg, 1862-65). To save space, such tables give only the least factor and exclude the numbers divisible by two, three or five.

But the most convenient table for those who do not want to go beyond a million is undoubtedly Chernac's "Cribrum Arithmeticum," published at Deventer (Holland) as far back as 1811. It gives *all* the factors of numbers not divisible by two, three or five. So that if one desires the factors of such a number 606697, it will be found at sight

$$606697 = 7.13.59.113$$

But if the number is 981423, it must be divided by three as many times as it will go

$$981423 = 3.3.3.36349$$

and the table entered with the quotient 36349. It will be found thus:

$$36349 = 163.223$$

The earliest factor table published in this country is probably the one contained in an arithmetic† (Philadelphia, 1844) by Pliny E. Chase, of Worcester city, an interesting sketch of whom has been written by Mr. Samuel S. Green, librarian of the Worcester public library. Another factor table has been calculated by Edward Hinkley, of Baltimore, which appeared there in 1853.‡ It contains the factors of odd numbers up to 20000, of even numbers up to 12500, and also the least factors up to 100000. In practice such tables are used for calculating change gears. Suppose that for a certain ratio, say that of a centimeter to an inch, 0,39370432, we find an approximate expression

$$\frac{4515}{11468}$$

it would be entirely out of the question to use such *ugly* numbers, as the machinists say. But by factoring the numerator and the denominator the following compound will be obtained

$$\frac{43}{94} \times \frac{105}{122}$$

which can be used in practice. Having now spoken of several separate tables, I proceed to describe in detail some remarkable collections of tables. Lambert, "Zusatze zu den logarithmischen und trigonometrischen Tabellen," Berlin, 1770.§ This little book, measuring six and three-quarters inches by four and a quarter in the cover, is undoubtedly one of the best collections of tables ever published. Not only the tables themselves, but even the introduction by that clear-headed Mulhouse mathematician, is worthy of a most careful perusal.

The book contains a factor table up to 10200, a table of prime numbers to the same extent, powers of 2, 3 and 5, hyperbolic logarithms, a table for the solution of cubic equations, hyperbolic functions, square and cube up to 1000, and the first eleven powers of all the hundredths parts of a unit, and a good many tables besides.

There is one passage in the introduction which proved to be very fruitful of results. Lambert speaks of his factor table up to 102000 and encourages people to extend it to a million, promising to such an undaunting and persevering one, in so far as it depends upon him, a similar immortality to that which Napier, Briggs, Vlack, Just Burge, Rheticus, Pitiscus, Gardiner and Sherwin obtained by their tables.

It produced a wondrous effect. In Germany, Austria, Holland, Sweden, France, calculators arose willing to perform the requisite task.

Some of their calculations never saw the light of day. Felkel's table, printed in Vienna in 1776 at the cost of the Austrian government, was used, for want of purchasers, to make cartridges in the war against the Turks, so that very few copies of it now remain. My own copy, which comes from the library of an Austrian mathematician who died at the age of ninety, is probably the only one in this country. Some had better fate, so that Chernac's excellent "Cribrum Arithmeticum" is not hard to get, even to-day.

There is an excellent likeness of Lambert, but as the readers of this article may not have access to it, it will not be amiss to translate here a description from the pen of a contemporary (Bernouilli):

"A true inward repose, a conscience whose serenity never had been troubled, a placidity amid active thinking filling his whole soul, never left Lambert up to his last moment. These were so impressed upon his whole countenance, that I do not know of any that could be compared to his in the slightest degree. When his soul worked without exertion with its whole strength, set in motion by an attractive idea, then his face was amazingly beautiful. There was a serene rapture upon it, something more beautiful and divine than I ever saw on the face of an antique Apollo or Minerva, something the ancients could not imitate because they had not the original before them. Since I observed that in him, I cannot bear such expressions as *cold* thinking, *cold* reasoning and the like."

The great mathematician Lagrange describes Lambert's death in the following way:

"I feel awfully sorry on account of Lambert's death. It is an irreparable loss to our academy and to Germany in general. He possessed in the highest degree the rare talent of applying the calculus to experiences and observations and to draw from them, so to speak, what was regular in them. His 'Photometry,' a book little known in France and even in Germany, is a true model in such researches. He was skilled in the calculus and was not a stranger in any branches of analysis or mechanics. The three volumes of essays which he published a few years ago contain excellent matter and it would be desirable to have them translated. All his researches are remarkable for their clearness, and he was particularly skilled in the art of obtaining the simplest results even in the questions which seemed to be the most complicated. He allowed himself to die little by little of consumption, having been unwilling, except during the last fortnight, to take any medicine or even to consult a physician. He had been endowed by nature with an admirable temper; always content with his lot and never showing the slightest feeling of envy or jealously toward any one. He had a certain naive way of thinking and acting, which very often alienated from him persons who did not know him well enough; but those who had fathomed him could not help entertaining for him the esteem and affection which he deserved; so it happened to me. If I envy his life, I envy as much his death, which was one of the gentlest, so that he did not even notice its approach."

Barlow, "New Mathematical Tables," London, 1814.*

These tables I consider as the nearest approach to Lambert's in the English language. They contain factors, squares, cubes, square roots, cube roots and reciprocals up to those of ten thousand. I spoke already of the use to be made of all these tables, except the last one. The reciprocals are used for division, but for such a use a table giving the nine multiples of the reciprocals is much more convenient. Such a table is Picarte, "La Division réduite à une addition," Paris, 1860.

Barlow's table contains, besides, the fourth and fifth powers up to those of one thousand, and the first ten powers up to one hendred. Such tables are very useful in calculating series. A table of prime numbers up to one hundred thousand and one of hyperbolic logarithms up to ten thousand are also included in the volume. A collection of useful formulæ closes the book.

The introduction, although a little out of date, is still useful reading, particularly from the point of view of numerical solution of equations for curve plotting or other purposes.

Kulik, "Neue Multiplications-Tafeln," Leipzig, 1851. This book consists of a table giving the products of two-figure numbers, which occupies pages 2–14, and a table of quarter-squares up to 30,000, which occupies pages 16–55. Of the first table it is needless to speak. It will be found very useful, whether for taking directly a product of two two-figure numbers or for performing much larger multiplications.

The quarter-square table furnishes a means of performing multiplications of four-figure numbers and occasionally of five-figure numbers, if their sum does not exceed 30,000.

I have on this occasion made a trial as to whether there is really any advantage in using a quarter-square table for performing multiplication of four-figure numbers. But the copy of the book I possess is unbound, and the paper is very thin, so that it takes some time to find the requisite page. It takes me fifty seconds to find the product of two four-figure numbers by means of it, while without it the same result could be obtained in thirty seconds, the time of writing down the numbers given included. Nevertheless, although the use of the table is rather the reverse of time-saving, I should still advocate it simply as a relaxation from the brain work required for performing multiplication in the usual way. I wish some of my readers who have access to Blater's table, described above, would compare the time needed to perform a multiplication of two five-figure numbers by means of it with the rapidity which can be obtained in the usual way.

The description of an arithmetical machine published by Captain Muller, in 1786, gives the time which it takes to perform the arithmetical operations in the usual way. I never saw Muller's book, but as an extract of it, given in the *Nouvelles Annales* for 1854, contains all the information which most of my readers would desire, I translate it for the benefit of those interested in the subject.

Time required for writing down and performing different arithmetical operations:

Addition.

	M.	S.
Two three-figure numbers	0	11
Two seven-figure numbers	0	24
Ten numbers, from two to four figures each	1	41
Ten twelve-figure numbers	4	26
Twenty numbers, from two to four figures each	1	42

Subtraction.

	M.	S.
Two numbers, from three to seven figures each	0	13
Two fourteen-figure numbers	0	48

* See *Popular Science Monthly*, vol. xxxvi., p. 546.

† A copy of it can be seen in the library of American Antiquarian Society.

‡ A copy of this work will be found in Peabody Library (Baltimore).

§ A Latin translation of this work was published at Lisbon in 1798 (Astor Library).

* Massachusetts State Library.

Multiplication.	M.	S.
Three figures by two	0	13
Seven figures by one	0	23
Five figures by two	0	36
Five figures by four	1	00
Seven figures by four	1	30
Eight figures by five	1	41
Seven figures by six	2	31
Eight figures by seven	3	24

Division.		
Three figures by two	0	18
Three figures by one	0	16
Five figures by four	0	42
Five figures by two	0	44
Eight figures by five	1	35
Eleven figures by six	2	10
Fourteen figures by eight	7	19
To divide 26938479633168 by 517425	4	40

Most of my readers will probably find that the last century calculators were rather slow. I must say, however, that the time required for writing down the numbers given is included in the number of minutes and seconds specified.

Nevertheless, for those who want a better exhibition of arithmetical skill, I subjoin the following extract* from Mr. Wood's "Account of Edinburgh Sessional School," which gives the rapidity obtained by the pupils of the said school:

"They will multiply such a line of figures as

76859281654879387764

by 7, 8, or any other figure, in less than the sixth part of a minute. From such a line they will *subtract* another of the same length in the ordinary way, in about seven seconds; and if allowed to perform the operation from left to right, while the question is under dictation (though it should be dictated with a rapidity which would not permit ourselves to take down merely the original figures), they will present the whole operation, both question and answer, in scarcely one second from the time of announcing the last figure. In *addition* they will sum up seven lines of eight figures each, in the ordinary way, in less than one-third of a minute, and if allowed to perform the operation while the question is dictating, in about three seconds. All other calculations they perform with proportional celerity. These modes of working during dictation (*when allowed*) are suggestions of their own, in their zeal to surpass each other, and not taught by the master."

I should refer those specially interested in the subject of mathematical tables to an excellent article by De Morgan, in the *Dublin Review*, No. 43, p. 74.

Clark University, May 3, 1894.

* This extract will be found in the *British Almanac* for 1844, which I had the opportunity of consulting in the Library of American Antiquarian Society, owing to the kindness of Mr. Barton.

THE LUMINIFEROUS ETHER.

By J. J. STEWART, B.A.Cantab., B.Sc.Lond.

IN the earlier theories of electricity and magnetism, "action at a distance" was considered a sufficient explanation of the mutual influence of electrified bodies or magnets upon each other. Bodies charged with electricity were stated to attract or repel each other with a force varying inversely as the square of the distance, and no account was given or inquiry made as to the mechanism whereby these attractions and repulsions were excited, though actions of material systems on each other at a distance without any intervening medium seems an unthinkable hypothesis.

To Faraday is due the fruitful theory that these electrical actions are caused by stresses and strains in a medium surrounding and interpenetrating the electrified bodies, and he mapped out the surrounding space by a set of curving lines of force. He showed that the actual phenomena may be explained by supposing a tension along the lines of force, combined with a pressure at right angles to them. This theory has been further developed by Clerk Maxwell, who showed that it gave a consistent explanation of the behavior of electrified bodies and of magnets.

But the existence of some medium filling interplanetary space is demanded by the undulatory theory of light, in order to account for the transmission of light waves from the heavenly bodies, and from all luminous objects to our eyes. Many facts go to prove that the dark radiations, which do not affect our sense of sight, but which produce heat in the matter on which they fall, are conveyed by the same medium, and that the heat-producing waves differ only from the luminous vibrations in having a greater wave length; the two radiations therefore seem to be essentially the same, but when the waves are shorter and more rapid than the luminous ones, they do not affect our nerves of sight, though their chemical effects may be observed and their existence made manifest by their photographic action.

The existence of a medium capable of conveying radiation by some sort of periodic vibration being abundantly confirmed by the various phenomena of light, the question arises whether it is not the very same medium whose stresses and strains may account for the observed electric effects. It would simplify matters much if we had not to suppose separate ethers to account for the various phenomena in the different departments of physical research. These various effects are considered by us separately and placed in different categories because they manifest themselves to us in differing ways, but they may all be due to different forms of energy exerting influence through the same medium. To reduce the explanation of physical phenomena to as few forces as possible is simpler and more satisfying to the mind, and the tendency of physical research and modern speculation is to form wider and more comprehensive generalizations, which enable us to include various and apparently disconnected phenomena under the same far-reaching laws. For the departments of electricity and light this has been to a great extent done by the famous electro-magnetic theory of Clerk Maxwell, which considers light as an electro-magnetic phenomenon, and explains the vibrations of light as consisting of some sort of alternate electric polarizations of the particles of the luminiferous ether.

Let us consider a little what is known of this all-pervading medium, through which are manifested all the remarkable effects of electricity and light and radiation.

Maxwell's theory has recently received a striking confirmation and illustration by the brilliant experiments of Dr. Hertz, who has investigated the behavior of long electro-magnetic waves, and has not only found that they are capable of reflection, refraction and polarization, but measured their wave length. He finds that their behavior is quite analogous to the behavior of light waves, and that they differ merely in having a greater length.

It is possible that the attraction of gravitation may also be due to stresses in the ether, though the cause of gravitation no one has yet been able to explain. It is highly probable that if we were acquainted with all the properties of the luminiferous ether, the knowledge would include an explanation of the mechanism of gravitation.

Newton emphatically rejected the idea of action at a distance. He says in his "Letters to Bentley:" "You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me; for the cause of gravity is what I do not pretend to know, and therefore would take more time to consider of it. It is inconceivable that inanimate brute matter should, without the mediation of something else which is not material, operate on and affect other matter without mutual contact, as it must do if gravitation, in the sense of Epicurus, be essential and inherent in it. . . . . That gravity should be innate, inherent, and essential to matter, so that one body may act upon another at a distance through a *vacuum*, without the mediation of anything else by and through which their action and force may be conveyed from one to another, is to me so great an absurdity that I believe no man who has in philosophical matters a competent faculty of thinking can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws, but whether this agent be material or immaterial I have left to the consideration of my readers."

Newton explained the phenomena of light as due to luminous corpuscles emitted with great velocity from shining bodies. He rejected the undulatory theory because he could not explain by it the propagation of light in straight lines, but some of his ideas closely resemble and agree with those of the theory of undulations; and he also supposed the existence of an all-pervading ether, and used the undulatory theory to account for the occurrence of reflection and refraction.

He imagined that his luminous corpuscles on striking surfaces produced waves in the ether, and by the action of these waves alternate fits of easy reflection and easy transmission were communicated to the luminous particles, so that sometimes they were in a state to be reflected and sometimes in a condition to be refracted at a transparent surface. He applies his observations on the colors of thin plates to this hypothesis, and develops it with extraordinary ingenuity. Many of his notions as to the waves produced in the ether agree far more closely with the undulatory theory than has been generally supposed. He compares the waves in the ether to those produced on throwing a stone into water. He says: "What kind of action or disposition this is—whether it consists in a circulating or a vibrating motion of the ray, or of the medium, or something else—I do not here inquire." He considered that vibrations or tremors were excited in the reflecting or refracting medium at the point of incidence, that they were propagated to great distances, and that they overtook the rays of light and successively put them into the fits of easy reflection and easy transmission. In the queries at the end of his "Opticks," he asks: "Is not the heat of the warm room conveyed through the *vacuum* by the vibrations of a much subtiler medium than air? And is not this medium the same with that medium by which light is refracted and reflected, and by whose vibrations light communicates heat to bodies, and is put into fits of easy reflection and easy transmission?" He gave as a possible explanation for gravitation that the ether was much rarer within the dense bodies of the sun, stars, and planets than in the spaces between them; that it grew denser and denser as the distance from these bodies increased, and thereby caused the gravitation of the bodies toward each other, every body tending to go from the denser parts of the medium toward the rarer. Again he asks: "Is not vision performed chiefly by the vibrations of this medium excited in the bottom of the eye by the rays of light and propagated through the solid, pellucid, and uniform capillamenta of the optic nerves into the place of sensation?"

The ether must be of extreme tenuity and imponderable. Its presence cannot be detected by our senses, and its properties must be discovered by a process of reasoning founded on its behavior, as manifested, for example, in the transmission of luminous vibrations. Its properties are to a great extent at present unknown. We know that it must fill the celestial spaces as far as the most distant stars; and from the propagation of light through transparent material we judge that the ether must evidently interpenetrate solids and fluids, for the matter of the solid body itself is incapable of transmitting vibrations with the enormous rapidity of those of light. From phenomena such as the polarization of light it is seen that the direction of the vibrations must be transverse to the direction of propagation.

As fluids cannot give rise to transverse vibrations, the ether was supposed to behave like an elastic solid, or at any rate to possess some property analogous to rigidity or resistance to change of shape. As a first step, the vibrations constituting light were regarded as actual periodic displacements of the particles of the ether in the wave front, and transverse to the direction in which the wave is moving. A solid gives rise to longitudinal vibrations as well as to transverse ones, and to get rid of the complication arising from the existence of the former the ether was supposed incompressible; then the velocity of propagation of the longitudinal disturbance would be infinite. Sir G. Stokes has pointed out that though the ether may act as a perfect fluid for large and comparatively slow displacements, those occurring in the propagation of light may be so small and so rapid that for them the ether behaves like an elastic solid.

The ether must be supposed to freely pervade all material bodies. As all bodies are compressible, their constituent molecules cannot be in contact, and the ether may be regarded as surrounding and bathing them, the molecules floating as it were in an ocean of ether. But the ether is affected by the presence of the molecules of matter, and this is shown by the bending or refraction of rays of light when they enter transparent substances. This refraction is accounted for in the undulatory theory by the difference of the velocity of the light waves through a vacuum and through ponderable matter. The presence of the particles of matter causes the speed of transmission of light to be less. At first sight it appears difficult to believe that a dense solid substance like glass should have its molecules so far apart as to allow of a free penetration of the ether among them, and that this contained ether should also be free to vibrate and thus transmit the periodic disturbances producing light. But we know that a magnet can act through a plate of glass and attract a mass of iron on the other side, and this magnetic influence must be conveyed through some medium from the magnet to the iron. Neither the magnetic influence nor the ethereal medium is directly observable by our senses, but the existence of both is inferred by our intellect from the effects produced.

From the fact that ether is capable of transmitting with a finite velocity the vibrations which convey light, it would seem to follow that it must be endowed with inertia, or some property answering to mass in ordinary matter. As these vibrations are transverse, it must also possess a quasi-rigidity or an elasticity analogous to that by which a solid body resists a force tending to change its shape, or opposes the gliding of its particles over one another. It may be continuous; at any rate, if it has a molecular structure, it must be different from that of gases, which cannot transmit transverse vibrations. If it be supposed to consist of molecules at a distance from each other, the same difficulty as to action at a distance between these separated particles would occur, for action at a distance across empty space is not more easy to understand when the distance is extremely small than it is when the distances are those we have to deal with in astronomy.—*Knowledge.*

RESISTANCE OF THE ETHER.

By DE VOLSON WOOD.

IN an article by S. Tolver Preston on "Some Remarks on the Kinetic Theory of Gases," published in the London *Philosophical Magazine* for May, 1891, are some remarkable statements in regard to the resistance of the luminiferous ether, which, if true, ought to have produced a measurable effect upon the velocities of bodies of finite size, if, indeed, it ought not to have destroyed the motion of planets.

Mr. Preston gives as a reason for his statement that "meteoric dust is measurably retarded from this cause." The truth of this statement is questioned. Nothing is known about the velocity of meteoric dust beyond the region of our atmosphere, and the resistance of the atmosphere alone is quite sufficient to account for the retardation—indeed, almost destruction—of any velocity with which such a fine dust-like substance may enter it. It hardly seems possible that a writer of such repute will consider our atmosphere as identical with the ether. Our atmosphere, if rarefied to the greatest degree to which it is possible by physical means—or to which it is possible to conceive—will not perform the functions of the ether. This is shown by means of the velocity with which a wave is propagated in the respective fluids. This velocity in a perfectly elastic medium varies as the square root of the elasticity divided by the square root of the density—or in symbols

$$V=\sqrt{\frac{E}{D}}$$

If the temperature be constant while the density is decreased, the elasticity will be decreased in the same ratio; so that, however rare the gas may be, the velocity of a wave will be constant, if the temperature be constant. In air such a wave has a velocity of about 1,089 feet per second. The *temperature* must be increased to increase the elasticity at constant density. The velocity of light in the ether is about 186,000 miles per second, or more than 900,000 times the velocity of sound.

In order that air should be able to transmit a wave at this velocity its temperature must be increased some 800,000,000,000 times that of its ordinary temperature, a value which at once precludes the possibility of air being a medium for the transmission of light. Moreover, with increased height in the atmosphere the temperature decreases, and at great heights becomes very low, so that this law still further precludes its serving as such a medium. The temperature of the ether is supposed to be very low—only a few degrees above absolute zero, if, indeed, it has any temperature. Assuming that the ether follows the gaseous law in transmitting a wave, it follows that the ratio of its elasticity to its density is some 833,000,000,000 times that of a similar ratio for air. The ether is not simply rarefied air, or other known gas.

Some years since I investigated certain properties of ether on the supposition that the laws governing it were the same as for those of perfect gases. (See *Philosophical Magazine*, November, 1885, and Van Nostrand's *Science Series*, No. 85.) I then showed that its resistance to the movement of planets and comets is exceedingly small—so small that it may be entirely discarded. We, therefore, infer that Mr. Preston has greatly exaggerated this resistance—if indeed it exists at all. And yet the action of the ether is modified by the presence of gross matter, as is shown by the reflection of light in passing from any medium to one more or less dense. A ray in passing from air into glass, for instance, is bent toward a normal to the surface; and the whole bending effect is produced at the surface of the glass, the ray going straight through the body of the glass. The reason for this is unexplained, but it is well known that the velocity of light is less in the more dense medium. The beautiful experiment of Michelson and Mowbry showed that the ether was carried along by a stream of water. These results may possibly be produced by the impact

of the particles of the ether directly against those of the gross matter, and not by friction between the molecules of these substances.

Mr. Preston considers that there is friction between the molecules, because the waves of heat and light contain energy. This reason is not satisfactory. We conceive that the office of the ether is merely one of transmission. A wave being once started in it, it is transmitted to a point more or less remote. So far as known, a wave of sound cannot be imparted to it; but it does receive actions from light, heat and electricity, and transmits the effect in the form of a wave, so called. A long rope suspended from a high point, if violently shaken at its lower end, will transmit to the upper end the energy imparted to it. The waves of the rope contain energy, but the rope performs no function in the generation of the energy—it simply transmits the energy imparted to it. Light being produced in some manner with gross matter—by chemical action, friction or some other mechanical means—an effect is imparted to the ether which it transmits with the known velocity of light. Every self-luminous body in the universe is sending out in all directions such waves, so that we must admit that in space the ether is full of waves which cross and recross each other; and yet so faithful and true is the ether in transmitting every wave impressed upon it, that one does not doubt the truthfulness of the impressions received. Thus we may suppose that a star, say, some ten years ago, started a wave which, having just reached the earth, writes its own record on some sensitized plates, though the star may be 6,000,000,000,000 miles distant, from which the scientist may learn that the supposed single star is actually double, and may determine their velocities in their orbits, the times of their revolution and their probable masses, without raising one doubt about the correctness of the record. What perfect faith! Who believes that there is friction between molecules in the interstellar space?

At the close of the discussion referred to above, the following conclusion was drawn:

"We conclude, then, that a medium whose density is such that a volume of it equal to about twenty volumes of the earth would weigh one pound, and whose tension is such that the pressure on a square mile would be about one pound, and whose specific heat is such that it would require as much heat to raise the temperature of one pound of it 1° F. as it would to raise about 2,300,000,000 tons of water the same amount, will satisfy the requirements of nature in being able to transmit a wave of light or heat 186,300 miles per second, and transmit 133 foot pounds of heat energy from the sun to the earth, each second per square foot of surface normally exposed, and also be everywhere practically non-resisting and sensibly uniform in temperature, density and elasticity. This medium we call the *luminiferous ether.*"

TRAVELING IN NORWAY.—Railways are comparatively few in Norway, owing to the cost of construction in a mountainous country, and to the disinclination of the people to speculative enterprise. The highways, however, are excellent, and one may "travel post" almost anywhere in a public carriole or post-chaise. The post stations are seven miles apart, and the traveler changes vehicles at each station.

HOW TO MAKE TELEPHONES AND TELEPHONE CALLS.

ON January 30, 1894, the Bell telephone patent expired and the invention became the property of the public; so that whoever desires to do so can make, buy or sell telephones without fear of infringing the rights of any one. This applies only to the hand instrument now used as a receiver. Patents for other telephone apparatus still remain in force; but enough is available for actual service. With two hand instruments and a suitable call, telephonic communication may be maintained, under favorable conditions, over a line eight or ten miles long, no battery being required.

To avoid the effects of induction and to secure the best results, a metallic circuit is required. It has been said, on good authority, that with hand telephones used as transmitter and receiver, conversation has been carried on between New York and Chicago, using a metallic circuit formed of heavy copper wire and having very low resistance. The words, it is said, were as distinct as where a transmitter is used, but the volume of sound was somewhat less.

For the benefit of those who are desirous of making telephones for their own use, or for sale, we present perspective and sectional views of the latest and most improved form of telephone, all of the parts of which are shown exactly full size.

The handle is made of hard rubber and the cap, which is also the mouthpiece, is of hard rubber. The diaphragm, A, is clamped at the edge between the cap or mouthpiece and the body of the handle. Very thin

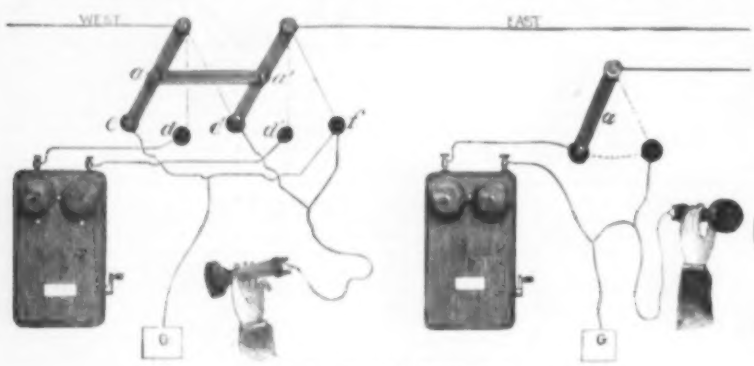


FIG. 2. SINGLE WIRE CIRCUIT. FIG. 3.

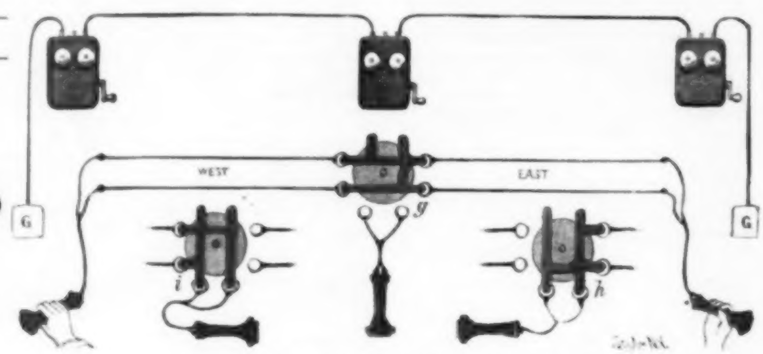
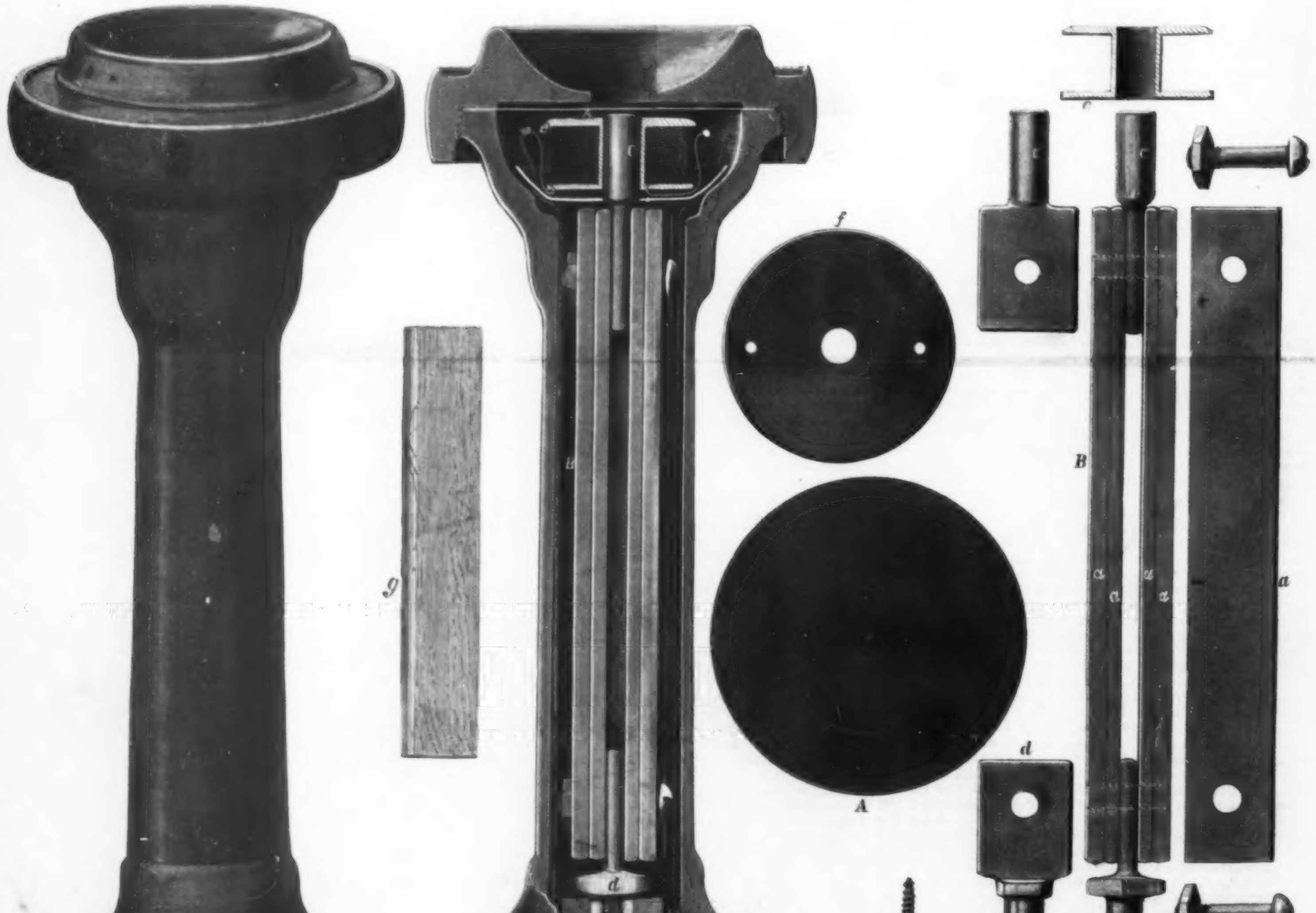


FIG. 4.—METALLIC CIRCUIT.



DETAILS OF CONSTRUCTION OF THE BELL TELEPHONE.

ferrotype plate has generally been used for the diaphragm, but thin taggers iron, when protected by a coat of shellac or other suitable varnish, is said to answer better.

The compound magnet, B, used in the telephone, is composed of four thin flat bar magnets, *a*, arranged in pairs on opposite sides of the flat end of the soft iron pole piece, *c*, at one end, and the soft iron distance piece, *d*, at the opposite end, the magnets being clamped to these pieces, with like poles all in one direction. The space in the center of the magnet between the pole piece and distance piece is filled with a strip, *g*, of wood.

The cylindrical end of the distance piece which extends beyond the magnet is bored and tapped to receive the screw by which the magnet is held in place in the handle. The cylindrical projecting end of the pole piece extends to within 1-100 or 2-100 of an inch of the diaphragm. In other words, it is placed as near the diaphragm as possible without being touched by the diaphragm when the latter vibrates.

On the pole piece, *c*, is placed a wooden spool, *e*, on which is wound No. 34 (Am. W. G.) silk-covered copper wire. The wire fills the spool, and its ends are allowed to project one or two inches. The wire may be wound on the spool in either direction, and it is immaterial which pole of the compound magnet adjoins the diaphragm.

The resistance of the winding varies from 70 ohms as a minimum to 200 as a maximum. When the instrument is to be used both as transmitter and receiver, and especially when it is on long lines, the resistance should be 100 ohms or more. No. 36 wire is used for the winding where the resistance is great. Of No. 34 wire, 263 feet will be required for 70 ohms resistance. For 100 ohms, 378 feet are required. For 150 ohms, 343 feet of No. 36 are required.

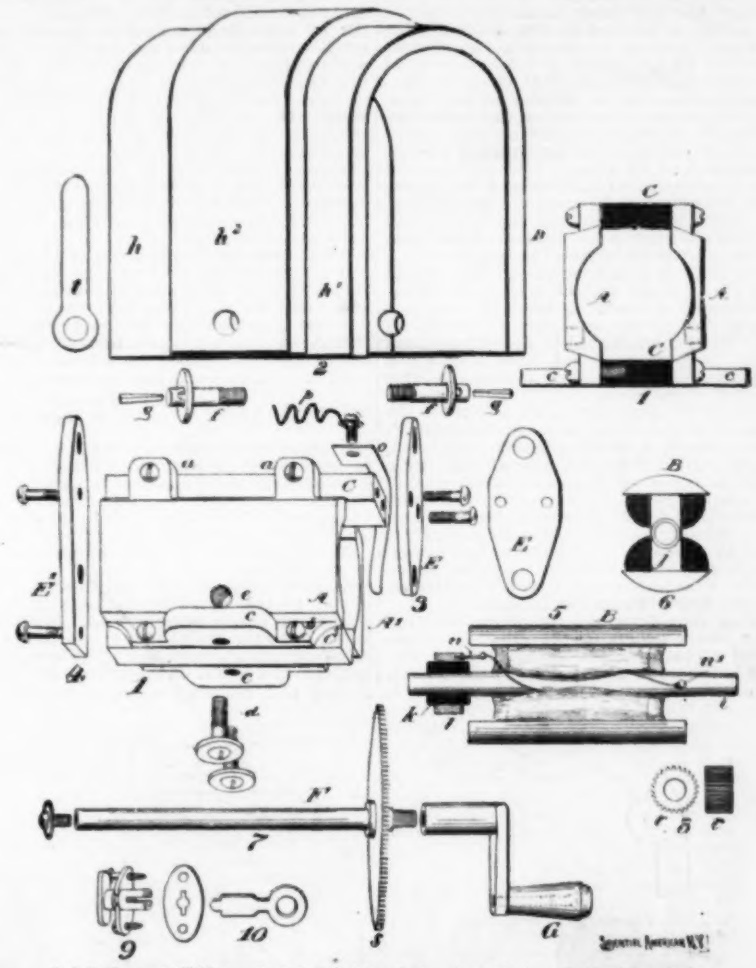
In the end of the handle are inserted two binding posts to which are attached insulated wires (No. 18), which extend toward the diaphragm, their free ends being soldered to the terminals of the fine wire on the spool so that when the telephone is connected up in circuit with other telephones the current will pass from one of the binding posts through one of the coarse wires, through the fine wire coil, through the other coarse wire to the other binding post.

The Bell telephone has a disk of flexible rubber slipped over the pole piece and over the ends of the coarse wires as a guard against short circuiting. A screw eye is inserted in the end of the telephone handle for suspending the instrument when not in use.

This telephone, when used in the manner suggested, requires neither battery nor induction coil. It is therefore easily connected up for use by electrically connecting the binding posts of one instrument with the binding posts of another. When a number of telephones are connected in the same line, the matter is not quite so simple. There are many ways of arranging the circuit; we give diagrams of two, one for one line wire with ground connections, the other for a metallic circuit, with a separate circuit for calling.

In the single wire circuit each instrument on the line is provided with a double switch cut into the line as shown in Fig. 2, the pivots of the switch arm, *a a'*, being connected with the line wire. The switch arms are pivotally connected with a bar of insulating material, so that they will move together. The arms, *a a'*, may be brought into contact with the points, *d*, *d'*, *e*, *e'*, and *f*. A magneto call box is connected with the points, *d d'*, and the arms, *a a'*, are left normally on these points, as shown in dotted lines, so that when any magneto in the line is operated the others will ring. All on the circuit have a special call.

The one called will know whether the signal comes from the east, west, north, or south. Suppose it to come from the east, the switch is placed in the position shown in full lines. This cuts out the magnetos, grounds the western section of the line through the point, *e*, and connects the eastern section with one end of the telephone cord through the point, *e'*, the other telephone connection being grounded through



1. Pole pieces. 2. Field magnet. 3, 4. End plates. 5. Armature, side view. 6. Armature, end view. 7. Driving shaft. 8. Pinion. 9 and 10. Door lock and key.

DETAILS OF MAGNETO CALL—THE GENERATOR.

the points, *f e*, and ground wire. If the call is from the west, the switch arms, *a a'*, are brought into contact with the points, *e' f*. The arms, *a a'*, are always left on the points, *d d'*. Outside the terminal stations the line is connected with the ground or arranged as shown in Fig. 3, with the line grounded through the magneto or telephone.

In the metallic circuit shown in Fig. 4, the terminal telephones are connected with the ends of the line wires. Intermediate telephones are cut into the line by means of a double switch as shown in the cut, in which *g* shows the intermediate telephone cut out, *h* shows it connected with the east and *i* with the west.

A third wire grounded at the ends, and including a magneto for each telephone, runs parallel with the metallic circuit. In this case all of the bells ring at once, and individual signals must be agreed upon.

It is obvious that the information here given in regard to the construction of the telephone may be departed from in minor points, such as the construction of the handle and mouthpiece, but everything relating to the magnet, the coil, and the relation of the magnet and diaphragm, should be strictly followed.

MAGNETO TELEPHONE CALL.

HOW TO MAKE A TELEPHONE CALL.

No telephone line is complete without a signal of some kind which will serve to attract the attention of a person in the vicinity of the instrument. A battery call answers very well for short distances, but for a distance of from one to twelve miles or more, the battery has been found impracticable and the magneto call is generally employed. This instrument not only serves a good purpose in connection with the telephone, but it answers very well indeed for general signaling purposes. It is always ready for action, and does not involve the care of a battery.

The line drawings presented herewith are one-half the actual size (linear measurement) of the instrument, and the perspective view is also one-half the actual size; the only dimension not obtainable from the drawings is the depth of the signal box, which is 3 inches. As all of the dimensions may be obtained from the engravings, it will be unnecessary to repeat them in the descriptive matter.

The pole pieces, A A', between which armature, B, revolves, are formed of soft gray cast iron, with ears, *a a*, at the top and the ears, *b*, at the bottom, separated by bars, C C', of non-magnetic material, such as vulcanized fiber, hard rubber, or they may be made from hard wood, well varnished or saturated with paraffine to prevent them from shrinking or swelling. The pole pieces, A A', are clamped to the bars, C C', before they are bored out. They are bored out to loosely fit the armature, B. The pole pieces are provided with flanges, *c*, which rest upon the bottom of the casing and are drilled to receive screws, *d*, by means of which the magnet is secured in place in the casing. In the pole pieces, A A', above the ears, *b*, are drilled and tapped holes, *e*, for receiving the studs, *f*, by which the horseshoe magnets are secured to the pole pieces. The studs, *f*, are drilled for receiving keys, *g*, by which the magnets are clamped in place.

The compound magnet, D, is composed of three flat steel bars forming U-shaped magnets, *h*, *h'*, *h²*, with the space between the poles adapted to receive the pole pieces, A A'. The magnet, *h²*, fits over the adjoining edges of the magnets, *h h'*, and the three magnets are drilled to receive the studs, *f*, which extend through the magnets and into the pole pieces, the parts being clamped together by keys driven through the holes in the studs, as shown in the perspective view.

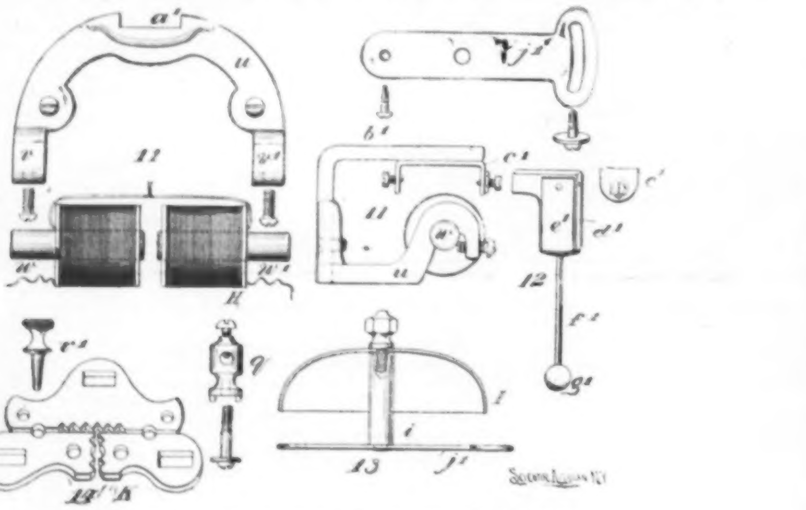
The armature, B, is the well known H type of Siemens, made of soft gray cast iron, the shaft, *i*, being cast integrally with the body of the armature. The part, *j*, which receives the wire is narrower and shorter than the polar extremities of the armature. The arma-

ture is turned so that its convex sides will revolve very near but not in contact with the pole pieces. The shaft at the ends of the armature is turned, and to one end is fitted a sleeve, *k*, of insulating material (vulcanized fiber or hard rubber), on which is placed a brass ring, *l*. In the inner side of the metallic ring, *l*, is inserted a stud, *n*, to which is soldered one terminal of the armature coil, the other terminal of which is soldered to a screw, *n*, inserted in the shaft, *i*. The armature is wound in the same manner as an electromagnet, the wire being carried around one arm of the armature until one-half of the wire is in place. It is then carried across the central portion of the armature and wound upon the other arm of the armature. The wire used is No. 34 silk-covered wire, there being about 1⅛ ounces of wire upon the armature, or enough to give it a resistance of 200 ohms.

To the bar, C, is secured a brass plate, E, by means of screws which pass through the plate and into the bar. In the plate, E, opposite the center of the bore of the pole pieces, there is a bearing for one end of the shaft of the armature, and in the opposite or upper end of the brass plate, E, there is a bearing for the driving shaft, F. To the opposite end of the bar, C, and to the bar, C', is secured a plate, E', which is also provided with bearings for the armature shaft and for the driving shaft. To the bar, C, is secured a curved spring, *o*, which bears upon the insulated ring, *l*, and this spring is connected by a wire, *p*, with a binding post, *q*, at the top of the casing.

Upon the end of the armature shaft, *i*, outside the plate, E', is placed a pinion, *r*, and upon the shaft, F, is placed a spur wheel, *s*, which engages the pinion, *r*. The shaft, F, is held in place in the machine by a screw inserted in the end of the shaft, and a washer held by the screw against the end of the shaft and bearing against the plate, E. The crank, C, by which the shaft, F, is turned, is screwed onto the end of the shaft through an aperture in the side of the casing. On the stud, *f*, projecting through the front of the magnet is placed a contact spring, *t*, which is clamped by the key which holds the magnet in place.

The mechanism thus described comprises the magneto generator which generates the alternating current required for operating the magneto bell. The machine is held in place in the casing by the screws, *d*, as already described, and the back of the casing is



11. Bell magnet. 12. Armature. 13. Bell. 14. Lightning arrester and cut-out.

DETAILS OF MAGNETO CALL—THE BELL.

cut away to let the magnet, *h*', into the back, thus economizing room. To the cover of the casing is attached the magneto bell, H, the magnet and armature of which are placed within the door, while the bells are placed on the outside of the door, the hammer extending through the door and between the bells.

The body of the magneto call consists of a curved casting, *u*, which is secured to the inner face of the door and provided with loops, *v v*', for receiving the soft iron pole pieces, *w w*', of the bell magnet. These pole pieces are held in place in the loops, *v v*', by screws passing through the side of the loop and bearing against the pole piece. The convex side of the casting, *u*, is provided with a rectangular notch, *a*', for receiving the L-shaped permanent magnet, *b*', which is held in its place by a screw passing through the magnet into the casting. To the L-shaped magnet, *b*', is secured a plate, *c*, which is bent twice at right angles, and in the bent ends of which are inserted pivot screws supporting the armature, *d*, which extends downward between the adjacent ends of the pole pieces, *w w*'. The armature is covered by a strip, *e*', of copper, and in the end of the armature is inserted a wire, *f*, carrying at its extremity a bell hammer, *g*'. To the outer surface of the door, and on opposite sides of the bell hammer, are supported two bells, I, by studs, *i*', projecting from adjustable plates, *j*', pivoted to the door at one end and provided with a curved slot at the opposite end for receiving a clamping screw, which passes through the slot and into the door. By means of this device the bells may be adjusted so that each will receive a stroke of the same power from the bell hammer, *g*'.

The spools on the pole pieces, *w w*', contain about 1½ ounces of No. 34 silk-covered copper wire. They are wound in the same direction, and the inside ends are connected together. The outer end of one spool is connected with the upper hinge of the casing, which, in turn, is connected with the binding post, *q*'; the outer end of the remaining spool is connected with a strip, *k*', of copper attached to the door and connected with a plate, *l*', which comes into contact with the spring, *l*, when the door of the casing is closed.

On the top of the casing there is a plug switch, which also answers as a lightning arrester. The rear plate of the switch is provided with the binding post, *m*, which is connected with the ground. The binding posts, *q q*', receive the ends of the line wire, the connections being made as shown in the article on the telephone in SCIENTIFIC AMERICAN, No. 5, last volume (February 3).

When the call is placed at the end of the line the call box is grounded by inserting the plug, *r*, between the rear or ground plate and the front plate that is not connected with a line wire. When it is desired to cut the call box out of the line, the plug is inserted in the circular space between the two front plates, the current passing from one end of the line through one of the binding posts and plate to the plug, the other plate and binding post to the other portion of the line. When the armature, B, is turned by revolving the crank, G, opposite ends are alternately presented to opposite poles, the consequence being that the rapid changes of magnetism in the armature induce alternate pulsations in the winding of the armature which operate the polarized bell of the instrument, also the polarized bell of the distant instrument, both being normally in the circuit.

While talking over the line it is important to cut out the magnet on account of its resistance, and while signaling over long distances the signals are more effective if the telephones are cut out of the line.

These machines can be purchased for $4, and we therefore doubt if it is profitable to undertake to make them; however, they may be made without fear of legal complications, as they are not patented.

SIZE OF HOUSE SEWERS.

As controversies occasionally arise between architects or owners and the health authorities as to the size necessary to the main house drain and sewer, it has been thought worth while to give somewhat in detail the data upon which the regulations of the New York Board of Health are based.

About a year ago the health department found that, in several cases, house sewers of the size which they considered essential for large buildings were not permitted by the co-ordinate department which has in charge the public sewer system. Correspondence followed as to the desirability of reaching a mutual and satisfactory understanding. This resulted in the preparation of a report on the subject by Messrs. Rudolph Hering and Horace Loomis, respectively engineer in charge of sewers and consulting engineer of the department of public works. This was accepted by the board, and its conclusions made the basis of their future requirements. The main points of the report on the deductions are as follows:

The first consideration is evidently as to the amount of water, per unit of surface, for which provision must be made. Formerly the records kept of rain storms gave merely the total fall per hour, leaving it uncertain whether this was uniform or, as more generally the case, the greater part had fallen in a comparatively short time. However, the meteorological observatory has obtained for a number of years an automatic record of the rainfall, showing for each storm the maximum rate and its duration, which evidently gives the data required for determining the size of the drains. These records show that, during the eight years from 1880 to 1887 inclusive, there were in all thirty storms with rates greater than one inch per hour:

Number of Storms.	Rate. Inches per hour.	Duration in minutes.
12	1 to 2	20 to 60
7	2 to 3	10 to 30
4	3 to 4	8 to 15
1	4 to 5	15
3	5 to 6	5
2	6 to 7	3 to 10
1	7·5	2

Thus in the eight years covered by the records there have been three storms with a rainfall of the rate of more than six inches per hour, lasting from two to ten minutes. As a very few moments of such a storm would wet and cool a roof or paved surface sufficiently to check evaporation, nearly the whole amount of water must have reached the house drain. It was therefore considered wise to provide for a maximum fall of six inches per hour, as the damage inflicted by a single storm, when the drains were insufficient, would more than outweigh the additional cost of the larger pipe. At the same time the other and equally important fact was kept in view that the drain should be made, as far as practicable, self-scouring under the ordinary conditions, and to accomplish this the diameter should be kept as small as may be consistent with safety.

The second consideration in determining the requisite size of the drain is the velocity of the water in the pipe. This should evidently be, not that derived from a theoretic equation, but such as can be attained in practice after making all due allowances for traps, short bends, etc. It was thought doubtful whether a velocity of six, or even five, feet per second could be obtained through a six inch quarter bend, unless the pipe was discharging full and under pressure. A maximum velocity of four feet was therefore assumed as safe.

Again, to prevent the drain running quite full, an available sectional area of 0·18 square foot was assumed for the six inch pipe. This, with a four foot velocity, would give a capacity of 0·72 cubic foot per second. With a six inch rainfall per hour one square foot of roof surface would receive about 0·000140 cubic foot of water per second. The six inch drain should therefore carry the water from about 5,000 square feet of surface, if it have an effective grade of one-quarter inch per foot.

With a grade of one-half inch per foot, which is often practicable, and a fairly straight run of pipe, the velocity may be raised to six feet per second, and therefore the capacity and amount of surface drained increased to one-half. In this case the six inch sewer would safely carry the storm water from 7,500 square feet of roof. The following table gives the size of pipes, with the corresponding area of roof drained when the effective fall is respectively one-quarter and one-half inch per foot.

Diameter of Drain.	Roof Area Drained. ¼ Inch Fall.		½ Inch Fall.	
6 inches.	5,000	square feet.	7,500	square feet.
7 "	6,900	"	10,300	"
8 "	9,100	"	13,600	"
9 "	11,600	"	17,400	"

For large areas it is always better to use two or more small sewers rather than a single large one, as under the ordinary conditions of sewage flow the small pipes will be more thoroughly flushed. The effective grade of the house drain should also, for safety, be measured from above the hydraulic grade line of the public sewer, which, in this city, during the heaviest storms, will be at least as high as the arch of the sewer.—*A. H. Napier, in Architecture and Building.*

VOICE CULTURE IN SCHOOLS.

By Dr. Z. RICHARDS, Washington, D. C.

VOICE is the utterance of sounds, by the use of the vocal organs; and it is peculiar to the human family; though almost all animals have sound organs.

Speech is the utterance of sounds, which represent names, thoughts and ideas; and it is peculiar to human beings alone.

The vocal organs are located in the larynx, or upper part of the windpipe, or trachea. The laryngeal or vocal organs are chiefly the vocal chords, which are a peculiar arrangement of membraneous ligaments stretched across the larynx in such a way that when the air is forced from the lungs, through the larynx, the chords are made to vibrate, like the strings of a violin; and produce the sounds of the voice.

By an all-wise providence, the muscles of the larynx, and of the mouth, are so made that they can modify and vary the sounds as they issue from the mouth.

There is hardly any faculty of the human body which shows more conclusively that our bodies are the product of an all-wise designing mind than the vocal organs. Here the small, delicate membranes in the larynx, not an inch long, can be so vibrated that by the variation of their tension one-fifth of an inch, two octaves or more in a man's voice, or twelve full tones, in the diatonic scale, and twenty-four distinct semitones can be given.

The voice has been so trained that the cultivated ear can distinguish five variations in each semi-tone; thus making the voice capable of one hundred and twenty distinct sounds, by varying the tension of the vocal chord one-fifth of an inch.

This shows that one of these one hundred and twenty sounds or tones, with almost innumerable modulations, can be made distinct to the human ear; results which are infinitely beyond all human skill.

Thus far we have had reference to vocal tones in music; but as vocal tones in language or in reading and speaking are of much more practical importance to humanity than those in music, it is very important that all our youth should thoroughly understand the nature and use of all the elementary vocal sounds of our language.

Of course, these vocal sounds are produced by the same organs as the musical sounds; but differ from them by the modulations which they receive from the muscles of the larynx and of the mouth. They are, however, greatly modified and improved by culture and proper use; quite as much as are musical sounds.

This culture should be given by the instruction received in the exercises of reading and of speaking; when the subjects of enunciation, articulation and pronunciation should be thoroughly mastered.

True enunciation is, so to speak, the diatonic scale of good reading and speaking. Until the sounds of this scale are fully mastered, no one can become a good reader and speaker, or a good talker; any more than he can become a good singer without mastering the scales of music.

It has been said that a certain American aspirant for a thorough musical education crossed the Atlantic, to avail himself of the skill and training of one of Europe's best singers.

For his first year his singing teacher kept his pupil upon the sounds of the musical scale; but at the end of the year the pupil hinted to his master that he would like to begin to read music; when his teacher said to him he must continue his training upon the sounds of the scale.

At the end of the second year the pupil said to his teacher, "Surely, I ought to begin to read music now, if I ever do." But his teacher coolly replied, "You must practice the sounds of the scale one year longer."

The somewhat disheartened pupil resumed his tasks upon the scale for another year; and at the close he said, "Now, surely, I ought to begin to read music."

The master replied, "You can now read any kind of music. I have finished my instructions; go back to

your country, and be not afraid to take up any kind of music."

So far as the use of the human voice is concerned, in reading or speaking, it would be a blessing to all who are obliged to listen to the English language if all our youth were obliged to go through a similar training in the elementary sounds of our language.

If the present imperfect, barbarous oral use of our language, in almost all our schools of learning and elsewhere, is ever to be laid aside, and a thorough training of the voice substituted, which will make oral reading and speaking intelligible and agreeable, or what it ought to be, some method of voice culture must be adopted by which perfect enunciation, articulation and pronunciation in the use of the elementary sounds is to be taught and mastered by teachers as well as pupils.

At present it is safe to say that not one teacher in fifty is sufficiently master of all the elementary sounds to teach and exemplify them, as they never do exemplify them correctly, when they talk or read in the presence of their pupils.

The essential requisites in good oral reading and speaking are, first, distinctness of utterance: second, good modulation, proper emphasis and correct pronunciation.

Distinctness of utterance requires correct enunciation, perfect articulation and good pronunciation, to which we have heretofore referred.

There are about forty-one distinct, simple and compound sounds, easily recognized in the formation of English words By a free and rigid analysis of English words some investigators make more than forty-one sounds, and some make less; but the forty-one sounds are sufficient to meet all the demands of our English language.

During the first efforts of the child in learning to speak, he should be accustomed to hear every word so uttered as to impress every elementary sound necessary to its perfect pronunciation upon his ear.

At the same time, he should be required in the school to enunciate every sound, in every new word which he learns by imitating his teacher until he is able to properly enunciate every one of the forty-one sounds as soon as his eyes rest upon the letter or letters which represent the sound.

By a regular practice of this kind, exemplified by the teacher, children can learn to give these sounds more readily and more accurately than they can learn the musical sounds of the scale.

Bear in mind that this teaching and practice should be kept up regularly and often, until the pupil gives good evidence of ability to master every sound without aid.

After the pupil has acquired some skill in imitating elementary sounds and word sounds, or pronunciation, he should be regularly exercised in *articulating*, or joining the sounds as they may be required in words and syllables. Any word of more than one elementary sound will furnish an exemplification.

To secure perfection in articulation, which is absolutely necessary for good reading and speaking, there is hardly any method more effective than analyzing each word into its true elementary sounds, and then of synthetizing or reconstructing the word, with the same sounds articulated.

In teaching the first lessons in reading, this exercise should be continued with all new words, until the sounds in each word will be suggested at sight, as readily as any note in any part of the musical scale will suggest its right sound.

Let it always be understood that at regular intervals, while the pupil is receiving this voice training, other necessary branches of learning should be just as carefully taught. Still, it should be ever borne in mind that the voice is one of the most wonderful and most important of all our physical faculties, and that as it has, heretofore, been almost entirely neglected in all our schools, it should now have a fixed and prominent place in every elementary school as next in value to good moral training.

As distinctness of utterance, or of enunciation and articulation, important as it will always be, is somewhat mechanical in its execution, and makes no large demand upon the mental powers, the vocal powers should always be cultivated with special reference to the intellectual powers.

Hardly less important than distinctness is the proper *modulation* of the voice.

In the utterance of language, as a general thing, the *manner* in which the voice is modulated indicates very decisively the reader's or speaker's appreciation of the meaning of the language uttered and most effectually impresses that meaning or fails to impress it upon the minds of all listeners.

The tones of the voice can be so modulated that they will indicate joy or grief, pleasure or pain, confidence or doubt, etc.

The prophet Ezra, and his assistant readers of the Book of the Law of God, are said to have read the Word *distinctly*, and to have given the *sense*—that is, they so modulated their voices as to impress the sense or meaning upon the minds of the people, that they could clearly understand and feel the truth; and, as if this was not enough, they caused them to understand the meaning either by repeating, or explaining, or illustrating the meaning.

The voice can be modulated in several ways, as follows:

1st. By varying the tone, higher or lower, with reference to the key note.

2d. By changing its quality—making the tones pure or smooth or rough or harsh.

3d. By changing the quantity of sound; as loud or soft.

4th. By inflections of the tone.

5th. By monotone—or using the same tone for all words.

6th. By emphasis—or by giving a louder or varied tone to the more important word or words.

All these modulations are to be governed by the sense or meaning of the language used, subject to the will of the reader. As a general thing they are to be governed by customary laws.

By common consent, these laws require uniformity of modulation; so that certain shades of meaning, and certain emotional language, will require uniform modulation.

All good oral reading and speaking require first: distinctness of enunciation and of articulation of all words and terms, and also of pronunciation.

Second, they require a proper modulation of voice adapted to the meaning of the language used.

Let us illustrate modulation of voice by referring to the familiar question, "Will you ride to town today?"

By varying the tones and inflections, this question may have six different meanings. Each word in this question may be emphasized by the inflections of the voice, as follows:

Will you ride to town to-day	?	[or to-morrow ?]
town	?	[or to the country ?]
to	?	[or part way ?]
ride	?	[or walk ?]
you	?	[or will your sister ?]
Will	?	[or have you no will ?]

But it may be that some adult person will say that "this voice culture is all right for the young people of our schools; but how shall we older people remedy our own defects, as we have left the schools?"

The remedy is at hand, for all who are ready to use it. Still, it must be admitted that very few persons whose voices and ears have not been properly trained in childhood and youth will acquire the same culture and skill in training their voices now that they would have done in their youth.

A long disuse of any physical power is destructive to the power itself.

The eyeless fish in the Mammoth Cave river have places for eyes, tightly closed, indeed, because the cave is totally dark, and they have no use for their eyes. Whether or not the eyesight of these fish would be restored if they were to be removed to waters exposed to common daylight, no one has yet satisfactorily shown.

But there is abundant evidence to prove that an adult, uncultivated voice can be greatly improved by use and good training, and in some cases reach a high degree of culture.

The best way, and in fact almost the only efficient and expeditious way of doing this desirable work, is to begin by practicing a careful and correct analysis of all common words into their elementary sounds.

This practice should always, at first, be under the direction of one who is master of the vocal scale or of the 41 sounds.

This practice should also include enunciation and articulation and pronunciation; and it should be continued regularly, until all the sounds can be enunciated and articulated correctly and easily.

As a general thing, if a speaker is not heard readily, the demand is made at once, "Speak louder." But oftentimes, and generally increased loudness increases the indistinctness. The direction should, therefore, be "Enunciate, and give every sound in each word clearly;" and then "articulate, or join the sounds distinctly and deliberately;" then let the voice be properly modulated, and there will be little or no difficulty in hearing by partially deaf people.—*Education.*

TIN-FOIL AS A FILLING MATERIAL.*

By DR. BENJAMIN LORD, New York.

MR. PRESIDENT AND FELLOW MEMBERS: The subject of the use of in-foil as a filling material is one, to my mind, of peculiar interest and importance; and the attention that it has received during the last six months is most encouraging, and promises much, I believe, in the treatment of the teeth in the future.

A paper was read recently before the First District Society having this title: "Has not Tin-foil, as a Material for Filling Teeth, been Overrated?"

I was very sorry not to be able to attend that meeting, to hear the paper read and listen to the discussions upon it. I do not know what views were advanced or what arguments were used to show that the value of tin-foil had been overrated; but, from my experience and observation, I do not understand that its merits or value can be overrated.

Now, those who place this high estimate upon tin-foil should have some good reasons for it.

It is said that we know the world, or learn the world, by comparison. If we compare tin-foil with gold-foil, we find that the tin, being softer, works more kindly, and can be more readily and with more certainty adapted to the walls, the inequalities, and the corners of the cavities.

We find also that tin welds—mechanically, of course—more surely than soft gold, owing to its greater softness; the folds can be interlaced or forced into each other, and united with more certainty, and with so much security that, after the packing and condensing are finished, the mass may be cut like molten metal.

I contend, moreover, that for contouring the filling or restoring the natural shape of the teeth, where there are three walls remaining to the cavity, tin is fully equal to gold, and in some respects even superior; as tin can be secured, where there is very little to hold or retain the filling, better than gold, owing to the ease and greater certainty of its adaptation to the retaining points or edges of the cavity.

It will be said, however, that tin fillings will wear away. The surfaces that are exposed to mastication undoubtedly will wear in time; but the filling does not become leaky, if it has been properly packed and condensed, nor will the margins of the cavity be attacked by further decay on that account.

Altogether I believe that we can make more perfect fillings with tin than we can with gold, taking all classes of cavities; but it must not be understood that it is proposed that tin should ever take the place of gold where the circumstances and conditions indicate that the latter should be used. Of course the virtue is not in the gold or in the tin, but in the mechanical perfection of the operation, and tin having more plasticity than gold, that perfection can be secured with more ease and certainty.

If we compare tin with amalgam, we must certainly decide in favor of the former and give it preference; as if it is packed and condensed as perfectly as it may be, we know just what such fillings will do every time. We know that there will be no changes or leakage of the fillings at the margins; whereas, with amalgam, the rule is shrinkage of the mass, and consequently the admission of moisture around the filling, the result being further decay. It is not contended that this is always the result with amalgam, but it is the general rule; yet we must use amalgam, as there are not a few cases where it is the best that we can do; but it is to be hoped, and I think it may be said, that as manipulative skill advances, amalgam will be less and less used. For so-called temporary work, very often I prefer tin to gutta-percha, as it makes a much more reliable edge and lasts longer, even when placed and packed without great care.

Gutta-percha is not infrequently left too long, and the surface of the filling becomes worn or softened, thus leaving the margins of the cavities exposed to further decay; and often, when we come to fill permanently, we find that the cavities are much larger than when we saw them first. I have felt that there was quite a good deal of risk to the best interests of our patients in leaving gutta-percha in the teeth very long, owing to this fact and to the uncertainty and almost impossibility of making perfect margins; yet it is an invaluable material in the treatment of the teeth.

I may say that I think we are now having a better article of gutta-percha than we have had hitherto—that which is called dentron; it has been brought out by Mr. T. B. Owens, of Boston. The most important quality that I have yet noticed in it is that a much more perfect edge can be made with it, owing to its greater density.

To get the best results from the use of tin as a filling material two or three considerations are imperative. First, we must have good foil. I have almost feared that the art of making the best tin-foil was, at least in some measure, lost. I have brought to the meeting some of a lot that Mr. R. S. Williams made about twenty-five years ago, to show to any who may be interested to see it.

I have made use of the same lot ever since and do not observe any change or deterioration in it. I have tried the tin made by Mr. Williams and various other makers since, and have never met with any so tough and strong as this.

Mr. E. Kearsing, of Brooklyn, says that he has developed a new method of making tin-foil. I have tried it and found it very soft and very nice; the best, I may say, that I have ever used, except that of which I have spoken, which I have been using so long.

Then, secondly, it is very necessary to have suitable instruments. I do not think that the best work can be made with the instruments that are in general use, even by trained hands. If any one does not believe that tin-foil can be made to do all that I have said of it, I would suggest or advise that he try what can be done; and the very best way to give it a trial is to have the teeth in one's own hand, and not in the mouth of a patient. Put the teeth into plaster, take the worst kind of cavities, have suitable instruments and a good foil, and you will soon find that you can do almost anything that you would like to in the way of filling a tooth.

I do not think that serrated points are as good or as suitable as a single point, or what might be called a diamond point, made so by a short bevel of the sides of the instrument at the tip. Be sure always to fold the foil into strips of suitable width for the cavity, and not to use it in rolls or pellets, or in any other form than strips.

Here I may relate an incident. Some twenty-five years ago I said at a large meeting of dentists that I believed that if tin-foil were used in all cases, considering the hands that fill teeth, more teeth would be preserved; and the sentiment was responded to by the clapping of hands. The idea or thought was that tin-foil required less training and manipulative skill to use it successfully than gold.

The question very naturally arises, Why has not tin been used to a larger extent than it is? Probably one important reason is, because it is not gold, and the popular feeling is in favor of gold, not considering whether it is better or as good as tin.

Another reason may be that many dentists have not learned to use tin, and so use amalgam instead. If I understand correctly, tin is used very little, nor is its use much taught in the dental schools, which, if true, is a grievous mistake.

I have considered, I wish to say, that the "new departure" theory, which was started some sixteen years ago and advocated with a good deal of enthusiasm by some, did not encourage manipulative skill in the use of foils, as it brought plastics into use to such an unwarranted extent that the training of the mind and hands in the use of the former was likely to be neglected.

* Read before the New York Odontological Society, March 20, 1894.—*International Dental Journal.*

PYROMELLITIC ACID CRYSTALS.

IN a communication to the Société Chimique, M. Girard explains the interesting fact that when wood charcoal is heated with sulphuric acid, for the purpose of preparing sulphur dioxide, colorless crystals are frequently observed to form. M. Terreil had previously pointed out the occurrence, but without offering any evidence as to its nature. M. Girard now finds that if excess of carbon is used, and the operation is continued until the complete cessation of the evolution of gas, so large a sublimate of the crystals is obtained as to cover the sides and neck of the flask, and to almost obstruct the delivery tube.

In order to purify the substance it is only necessary to dissolve it in water, boil until sulphur dioxide is expelled, precipitate any sulphuric acid by the necessary quantity of barium chloride, evaporate to dryness, and recrystallize from alcohol. The well formed colorless crystals obtained are found to consist of pyromellitic acid, $C_6H_2COOH)_4$, one of the isomeric tetrabasic acids of the benzene series, and the acid whose anhydride is produced when mellitic acid is heated. Mellitic acid is a substance well known from the fact of its occurrence in combination with alumina in honey stone. The crystals of pyromellitic acid obtained in the interesting manner above indicated are soluble without decomposition both in boiling sulphuric and boiling nitric acids.

Their aqueous solution reacts like an ordinary dilute acid, decomposing carbonates with effervescence. The crystals themselves are efflorescent in the air, and upon heating thay volatilize with production of a sublimate of long needles, melting about 280°, and which prove to be pyromellitic anhydride. M. Girard further shows that when sulphuric acid reacts upon wood charcoal

which has previously been well calcined at a white heat or upon coke, no production of pyromellitic acid is observed. On the other hand, substances richer in hydrogen and oxygen than wood charcoal, such as the denser varieties of cellulose, yield it in relatively large quantities. It appears, therefore, to be produced by the action of sulphuric acid upon that portion of the wood charcoal which is least carbonized and retains a larger proportion of hydrogen and oxygen. Now it is well known that pyromellitic acid may be obtained by the action of sulphuric acid upon mellitic acid. M. Verneuil has recently shown, while these experiments of M. Girard were in progress, that when sulphuric acid acts upon wood charcoal a certain amount of mellitic acid is produced. It is therefore practically certain that by the action of sulphuric acid upon wood charcoal, in addition to the production of the gaseous dioxides of sulphur and carbon, mellitic acid is produced, which in turn is converted by a further quantity of sulphuric acid into pyromellitic acid, and the latter is deposited in crystals in the cooler portion of the flask in which the reaction occurs.—*Nature.*

MAN'S WORK IN DEFENSE OF PLANTS.

By JOSEPH F. JAMES, M.Sc., Assistant Pathologist, United States Department of Agriculture.

SOME one has said that the three scourges of China are droughts, floods, and locusts. When droughts come, its miserable victims creep into their hovels to die uncomplainingly. When floods wreck their fury upon the land, pick and shovel are used at once, and, with the energy of despair, the people set about repairing the damaged embankments. When locusts settle like a blight upon the crops, the fatherly emperor orders out his soldiers to assist in an unequal battle with the hungry hordes of insects. The army in these battles is not supplied with guns. Each solder is armed with a long bamboo pole having a coarse hempen bag attached to it. This is waved vigorously to and fro amid the settling swarms, and when the bag is filled the carrier marches to some designated spot to have his victims destroyed. The peasantry assist the soldiers in the work, and assemble in the fields armed with long bamboos with streamers flying from their ends. With these and with shouts and beating of gongs, they endeavor to frighten the settling crowds. They likewise provide themselves with large brooms made of bamboo and other twigs with which to destroy the insects. The dead insects are paid for by the government at the rate of about four cents per pound. The eggs are also collected and paid for at the same rate.

There is a popular belief among the people that the swarm is led by a king or "wang" locust, an insect of colossal size, which hovers invisible in the air and directs the course of the insects. This belief seems to be shared by high officials as well by the peasants, and the magistrates frequently offer sacrifices to the "wang" to induce him to direct his swarms elsewhere. They know full well the importance of saving the crops of their own immediate neighborhoods, because they are liable to lose their "buttons"—those important insignia of rank—if the damage to the crops be too great. In some districts great flocks of ducks are kept to assist in the work. Sometimes as many as 3,500 are in a single flock, and as they are trained to march in a body and to devour all insect life, their work of destruction is nearly as complete as that of the soldiers. A writer in describing the work of these ducks says that one day he came upon a spot where the locusts were unusually numerous. In the distance was a small army of the birds directed by five or six men and boys. The march was guided by the voice and by long bamboo poles. A small boy, about 12 years of age, stark naked, and bronzed by the sun, saw the insects and, with a shrill yell, called to the men. In a few moments the ducks came up, fell upon the locusts and gobbled them up with great rapity.

The Chinese locust is described as resembling an ordinary grasshopper, and presents many resemblances to the locust of the Rocky Mountain region. The female is dingy brown, about 2½ inches long, and larger than the male, which is yellow. The insects fly in enormous swarms, taking advantage of a strong current of air when there is one, by keeping their bodies transversely to the wind and being thus passively borne along. They have, however, a strong flight of their own, moving 20 or 30 feet per second on a calm day.

China is of all countries in the world an agricultural one, and when droughts or floods or locusts threaten the subsistence of her teeming millions every available art must be used to repair or to prevent the damage. It cannot be questioned but that to employ the army to destroy swarms of locusts is far more laudable than to allow the soldiers to live upon the fat of the land. At the same time there are other means of fighting insects. The Chinese methods are in striking contrast to the newer ones that science, and especially the Department of Agriculture, has evolved.

As far back as history carries us we find mention of devastation by insects. The plagues which afflicted Egypt during the reigns of King Meneptah and his son Seti, who lived during the time of Moses, were probably of this character. We have also accounts in more recent years of their work in Northern Africa and Southern France; and we know all too well of the disastrous work of these locusts among the corn and wheat fields of our great trans-Mississippian States.

Plagues such as these have been credited with much worse effects than destroying man's plants. They have destroyed man himself. In 1478 the country about Vienna is stated to have been invaded and 30,000 people to have died of famine; and a previous plague in Mesinissa is credited with causing the death of 800,000 men.

In this country, as in others, the aid of the government has been invoked to check the ravages of the destroyers; and the Agricultural Department is now in a position to show that the aid has not been asked in vain. It is now known that these swarms are the progeny of nature, and biologists have learned, by a study of their habits and mode of life, whence they come and whither they go.

There are several insect pests afflicting our country whose ravages have been sufficient to attract the attention of the State or general governments. Among the more important are the Colorado potato beetle, the Rocky Mountain locust, the army worm, the cotton worm and the chinch bug. Some of these confine their attention to one species of plant, while others, like the locust, are omnivorous. The general means for the destruction of these is somewhat the same, so that a mention of means for one will frequently cover the others. But at the same time each has special methods by which the ravages are prevented.

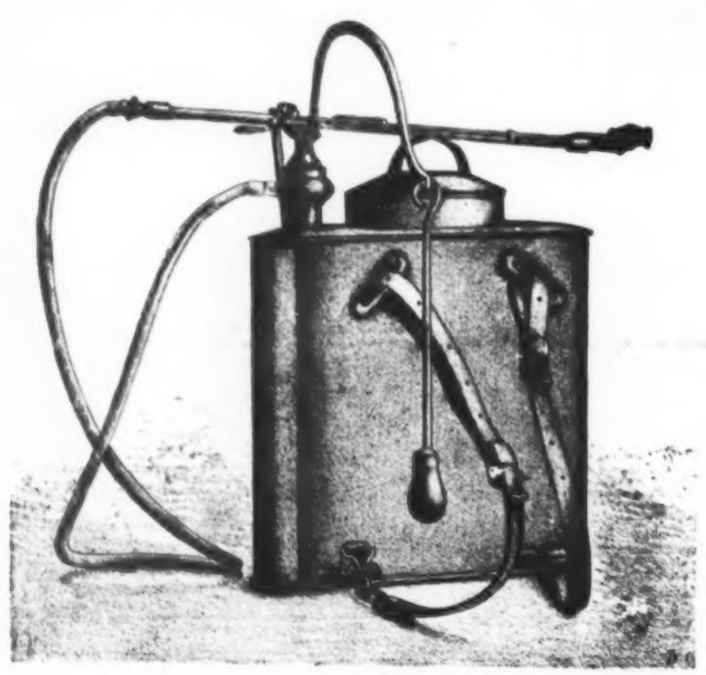


FIG. 1.—KNAPSACK SPRAYER.

The first one of the pests to attract general attention was the Colorado potato beetle. A native of the far Northwestern Territories, it fed upon plants allied to the potato, and only upon the extensive introduction of this tuber in its vicinity did it leave its original food plant to fasten itself upon man's staple article of diet. With its increased supply of food there was a marked increase in its numbers. It spread eastward rapidly, and in 1864 and 1865 crossed the Mississippi River into Illinois. Since then it has swept over the whole country and has also been occasionally found across the ocean.

When the insect first crossed the Mississippi River the consternation of agriculturists was intense. Starvation stared the farmer in the face. But with the characteristic energy of an American, he set at once to work to combat this apparently unconquerable enemy. The first means adopted in this case, as in others, were mechanical. The insects were picked off by hand; they were knocked off the plants into pans and killed; they were crushed between wooden pincers. In spite, however, of all the efforts of the farmer, the hosts multiplied and increased. But about 1872 it was demonstrated that Paris green could be used with success in destroying the beetles and their larvæ, and the farmer now had the battle in his own hands. After the remedy came the methods of applying it. These were crude at first. The dry Paris green was spread by hand by means of tin boxes with perforations at top or bottom or by means of bellows. Later on it was found that the poison could be used as effectually in a liquid as in a dry form, and then spraying machines were introduced. It would be too tedious to trace the history of the changes in these machines. It must suffice to say that the earliest form was a simple tank holding about eight gallons, which was strapped upon the back and provided with two tubes set in the bottom. Each of these was furnished with a rose or sprinkler upon the end, and by them two rows of vines were sprinkled at one time as the man walked along.

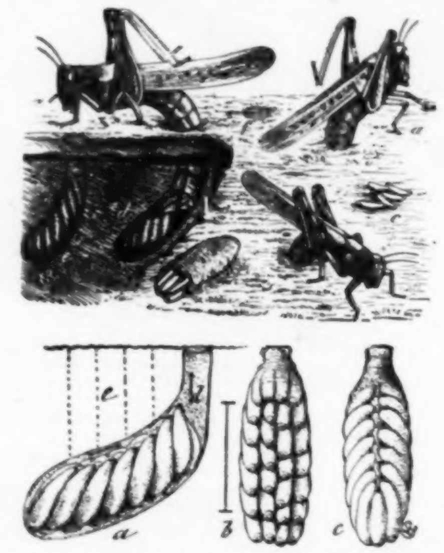


FIG. 2.—ROCKY MOUNTAIN LOCUST AND EGG MASSES.

The great advance in these forms of apparatus is shown by the latest improved knapsack sprayer (Fig. 1). This is made of copper and holds about five gallons. It has on the inside a small force pump worked by a handle with one hand, while the tube for the liquid is held in the other. This tube is provided with a nozzle so arranged that the liquid is divided into a fine spray and is thrown with considerable force. It is further so arranged that in case the tube becomes clogged, it is cleaned out by touching a spring. For treating large patches of potatoes an enlarged spraying apparatus can be mounted upon a cart with two wheels and drawn by hand or horse power through the field, the spray being directed to either side by a double discharge hose.

So much progress has been made by man in treating this one of the worst foes of his cultivated plants, that it may be said to have passed beyond the experimental stage and to be an established fact. Let us now turn to another pest, in combating which certain peculiar difficulties have been encountered, and to overcome which certain specially contrived pieces of apparatus have been found necessary.

The ravages of the Rocky Mountain locust in our Western States and Territories led in 1877 to the estab-

FIG. 3.—KING SUCTION MACHINE FOR DESTROYING LOCUSTS.

lishment of a commission to study and report upon the habits and means of destroying these insects. Like the potato beetle, this insect has its home in the far Northwest, but unlike it, it is periodical in its appearance, and only causes great destruction in certain years. The report of this commission gives an account of the habits, distribution, anatomy and all facts relating to the insects obtainable.

Periodically since 1818 "grasshoppers" have ravaged the Western States. In that year they were said to have been so numerous as to cover the ground three or four inches deep. In 1874 they caused a loss estimated at $50,000,000 in States west of the Mississippi, and in 1875 Missouri alone is stated to have suffered to the extent of fifteen million dollars. In 1876, at Austin, the Texas Central R.R. was compelled to stop its trains occasionally during ten days to clear the track of the 'hoppers. At Dallas the swarm was estimated to be two thousand feet high and from forty to sixty miles wide. The swarms are described as falling upon cornfields, and converting in a few hours "the green and promising acres into a desolate stretch of bare, spindling stalks and stubs. Covering each hill by hundreds; scrambling from row to row like a lot of young famished pigs let out to their trough; insignificant individually, but mighty collectively, they sweep clean a field quicker than would a whole herd of hungry steers. Imagine hundreds of square miles covered with such a ravenous horde, and one can get some realization of the picture presented in many parts of the country west of the Mississippi during years of locust invasion.

"Their flight may be likened to an immense snow storm extending from the ground to a height at which our visual organs perceive them only as minute, darting scintillations, leaving the imagination to picture them indefinite distances beyond. 'When on the highest peaks of the Snowy Range, fourteen or fifteen thousand feet above the sea, they have been seen filling the air as much higher as they could be distinguished with a good field glass.' (Byers.) It is a vast cloud of animated specks, glittering against the sun. On the horizon they often appear as a dust tornado, riding upon the wind like an ominous hail storm, eddying and whirling about like the wild, dead leaves in an autumn storm, and finally sweeping up to and past, with a power that is irresistible. They move mainly with the wind, but when there is no wind they whirl about in the air like swarming bees. If a passing swarm suddenly meets with a change in the atmosphere, 'such as the approach of a thunderstorm or gale of wind, they come down precipitately, seeming to fold their wings, and fall by the force of gravity, thousands being killed by the fall, if it be upon stone or other hard surface.'" (Byers.) (First Report of U. S. Entomological Commission.)

South America has had her share of visitations. In 1835 a swarm is described where "the main body filled the air from a height of twenty feet to that, as it appeared, of two or three thousand feet above the ground. The sound of their wings was as the sound of chariots of many horses running to battle; or rather (as I should say) like a strong breeze passing through a ship's rigging. The sky, seen through the advanced guard, appeared like a mezzo-tint engraving; but the main body was impervious to sight. They were not, however, so thick together but that they could escape a stick waved backward and forward. When they alighted they were more numerous than the leaves in the field, and the surface became reddish instead of green."

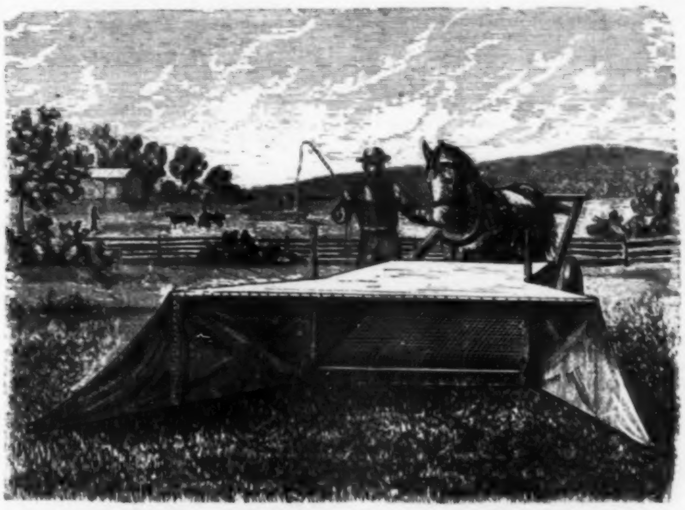


FIG. 4.—FLORY LOCUST CATCHING MACHINE.

The locust, like the Chinese species, is a grasshopper in form. It is only about one and one-quarter inches long, pale brownish in color, with small squarish spots arranged along the median line, and with the body of some shade of brown. In the case of this insect, methods have been adopted differing from those used against the potato beetle. This has been rendered necessary by the different manner in which it causes its injuries, migrating in swarms instead of singly, and the hinder bodies continually seeking new pastures beyond the devastated country over which its predecessors have passed. The method of ovipositing, that is by egg masses (Fig. 2) buried in the ground, brought into prominence the necessity for some means of destroying these. This destruction of the eggs has been recognized in Europe since the time of Pliny as more efficacious than destroying the mature insects. In those countries where the price of labor is such as to permit it, the eggs may be collected by taking off the surface soil, and, after drying, sifting them out. But in this country, where labor is scarce and where large tracts of ground are infested, other means must be employed. Among these there have been suggested harrowing the ground in autumn, so as to expose the eggs to the alternate freezing and thawing of winter, or by breaking up the egg masses expose the individual eggs to influences which would not affect them *en masse*. This has been found to be successful where it can be practiced. Another method is by plowing, so that the eggs are covered with earth to a depth of six or eight inches. But, in addition to this egg destruction, means were necessary to destroy the larvæ and the mature insect, and for this purpose innumerable machines have been contrived. Some work upon the principle of crushing the insects by rolling over the ground, others by a drag, and still others by catching the insects in a hood and then by a system of revolving drums between which the insects must pass, destroying them. Another (Fig. 3) depends for its success upon sucking up the insects from the ground into tin tubes, from which they are drawn by a revolving fan and thrown upon a screen, thence dropping into a hopper and then into a bag. This machine is drawn by two horses. Still another method is by means of a wide open canvas frame (Fig. 4) mounted upon four low wheels. Inside the frame is an endless wire screen passing between two rollers. The hoppers, caught by the wide open mouth, are thrown upon the wire, crushed between the rollers, and drop to the ground. This machine is pushed by a horse fastened behind, so that we have here almost literally exemplified a condition of "cart before the horse."

Of all the liquids, coal oil or coal tar is the most effective in its destructive action. These substances may be used either on irrigating ditches or in pans. Their action upon the insects is immediate. In the irrigating ditches of Colorado a few drops of tar are sprinkled upon the water. The oil is rapidly diffused, and, coming into contact with the insects, causes their instant death. A single drop floating on the water is capable of destroying large numbers. The method of supplying the ditch with tar is to immerse a three quart can, with a small hole in the side near the bottom, in the ditch, and insert a chip loosely into this hole. "Three quarts or less of tar trickling out drop by drop from this slight vent are sufficient to keep a great length of ditch supplied with oil for thirty-six hours. The precise extent of ditch which may thus be rendered toxic to the locusts cannot, of course, be exactly stated. It is, in fact, quite indefinite, for the reason that the quantity of oil necessary to kill one of the insects is almost infinitesimal, and for the further reason that a single drop of oil will cover quite a large surface when dropped into water; so that, taking these two facts together, it is easy to see that a very small quantity of tar or oil will serve to guard, by means of ditches, a large tract of territory from the ravages of the young (unfledged) locusts." (First Rept. U. S. Entom. Commission.)

The pans made for using oil or tar are very simple. One is described as about eight feet long, made of ordinary sheet iron eleven inches wide at the bottom, turned up a foot high at the back and an inch high in front. A runner at each end, and extending some distance behind, and a cord attached to each front corner, completes the whole. It can be drawn by a horse or boys. A simple form known as the Robbins hopperdozer was extensively used in Minnesota in 1877, and with great success.

A third pest to be considered is the cotton worm. This is confined to the Southern States, where for more than a century it has done immense damage. The ravages of this cotton worm are calculated to have caused a loss of over $15,000,000 annually from 1865 to 1880. Both the larvæ and the mature insects of the potato beetle and of the locust feed upon the plants. With the cotton insect, however, it is the caterpillar or worm alone that does the damage. This when full grown is about an inch and a half long, generally of a pea green color, with many black lines along the back and black spots arranged in rows along both sides of the body. The insect, from the time of its birth, can not only let itself down by a web, but it can also throw itself from one plant to another. "The fling or jump is made by bending the fore and raised part of the body to one side, and then suddenly jerking it to the opposite side, relaxing meanwhile the three hind pairs of legs by which it held to the plant. . . . The maximum distance which a worm can thus jump in a horizontal direction is about three feet, and it almost invariably alights on its legs." (Report on Cotton Worm, p. 7.)

The moth is about $1\frac{1}{4}$ to $1\frac{1}{3}$ inches across the wings when expanded, olivaceous in color above, more or less subdued by purple hues, and often with a clay yellow or faintly golden cast. There are undulating carmine lines across its front wings and a dark oval spot near the disk. The natural food of the moth is the sweet exudation from glands on the midrib of the leaf and at the base of each lobe of the involucre of the flower of the cotton. Naturally, therefore, it deposits its eggs upon the leaves, and these hatching out, the young worm finds its food ready at hand.

The methods which have been used to destroy the worms have been as varied as in cases previously mentioned. They resemble them in some respects and differ in many others. The early method was by hand picking. Then fowls, especially turkeys, were kept in great numbers, these birds devouring large quantities of the worms. Then the plan was adopted of carrying lighted torches through the fields at night to attract the flying moths. Large fires were used for the same purpose, but all these methods have fallen into disuse for obvious reasons. Practically now the methods can be divided into the use of dry and liquid preparations, which may and may not be poisonous to man. Of the dry preparations, compounds of arsenic (such as Paris green and London purple) and various insect powders, like Pyrethrum, are used, Of the liquids there are mainly two, solutions of Paris green and kerosene emulsion. We have already seen that Paris green acts as an insecticide against the Colorado potato beetle, and that coal oil or tar is an effective remedy against the locust. With some modifications, both are employed to combat the cotton worm. It has been shown that when applied dry, Paris green must be mixed with some diluent, such as flour, road dust, ashes, etc., and in this form it is still used; but its action is so much more effective when dissolved in water that practically it is now used only in this way. Kerosene, on the other hand, when applied undiluted, has as bad an effect upon the plants as upon the insects. While it kills the worms promptly, it almost equally promptly burns and destroys the leaves. Many experiments have shown that when made into an emulsion, however, it can be used with

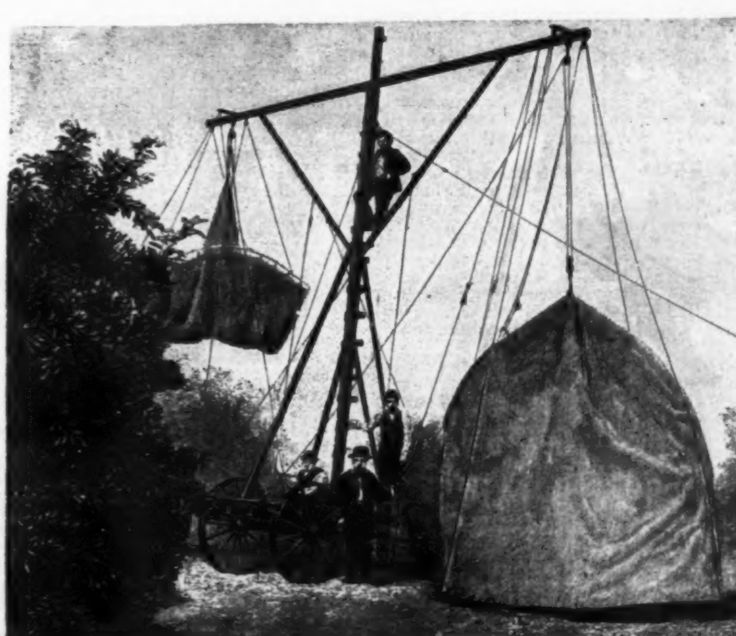


FIG. 5.—APPARATUS FOR FUMIGATING ORANGE TREES FOR SCALE INSECTS.

success. This emulsion was at first made with milk, but later on with soap, the former being too expensive.

From the fact that the cotton worms feed mostly on the *under* sides of the leaves, it was found necessary to modify the previous forms of spraying machines so as to get at these lower surfaces. To accomplish this, spraying apparatus had to be greatly modified by instituting deflecting nozzles, and at the same time the area to be covered being large, the spray had to be enlarged. Some of these nozzles are very complicated. One is made with three jets which, although arising from the same source, radiate from each other and strike a deflecting plate at such an angle that all of the sprays coalesce to form one, which is very broad and semicircular or circular in outline.

Some of these deflecting nozzles are used for powders and some for liquids. They are attached to pumps carried on the back, with the nozzles dragging on the ground behind, and worked with a crank, or they are worked with bellows carried under the arm. The principle is the same in both cases, as indeed it is in all the machines especially designed for destroying the cotton worm.

For the extensive distribution of poisons, tanks or barrels mounted upon wheels or placed in wagons and provided with various forms of discharge hose have been invented. One of these, known as the "nether spraying machine," is made by placing a common barrel, in which is a force pump, in a wagon. This pump is worked by one man, while the wagon is driven by another. Connected with the barrel is a discharge pipe which passes over the end of the wagon to a horizontal pipe, from which again there are several pipes extending to the ground. Each of these pipes is divided into a V, and at the ends of the arms of the V are the deflecting nozzles forcing the spray upward. The distance between the nozzles is so arranged that each one runs along a row of plants and sprays both sides.

As the tubes are flexible, they conform to any irregularities in the ground and do not require any special manipulation. An enlarged edition of this can be arranged so as to spray a strip sixty feet wide. This machine will spray sixteen rows at one time, and, notwithstanding its great width in the field, it can be so narrowed when unhinged as to pass through an ordinary farm gate.

Still another form of apparatus acts by the force of gravity. This is one of the most ingenious of all machines. It does away with the force pump, and one man and one mule can operate it. It is mounted upon a triangular frame with wheels at the corners, and arms extending out on either side. On the frame is a tripod, with windlass and pulley, holding the barrel or half barrel with the poison. The barrel is about ten or twelve feet above the ground. A lever allows the driver to shut off the stream of poison at will. The apparatus will poison about twelve rows at one time, covering a strip about forty feet wide. Ten or twelve gallons are sufficient to spray an acre.

Among the smaller pests which affect man's cultivated plants are scale insects—minute organisms which multiply with marvelous rapidity and cause destruction to the foliage of orange and other trees. The problem of destroying these pests has been approached in two ways, one by increasing natural enemies to keep pace with their own increase, the other to destroy them artificially. The former has been to some extent very successful; the latter has been so perfected as to more than fulfill expectations. In speaking of the artificial increase of the natural enemies of the scale, it should be premised in the first place that the white cottony scale which for twenty years ravaged the orange groves of California is a native of Australia, whence it was imported into California. In its native country it is preyed upon by insects of various kinds, which keep it in check and prevent its excessive increase. But when the scale was brought to the Pacific slope the parasite remained behind, and it was at the instance of the United States Entomologist, Dr. C. V. Riley, that an agent of the Department of Agriculture was sent to Australia to collect specimens of these parasites. One of the most important is a small beetle known locally as a "ladybird," and scientifically as *Vedalia cardinalis*. This was the natural enemy of the white scale, and as such was desirable to acclimate.

The agent was sent in August, 1888. Several shipments were made to the local agents in California, and as fast as they were received they were placed in tents surrounding trees infested with the scale, where they were allowed to breed. By April, 1889, the trees had been nearly cleared of scales and the ladybirds had multiplied so fast that the agents in charge began sending out colonies to orange growers. By June 12 over 10,000 had been distributed, and so successful were the beetles in destroying the scale that in large orchards that had been badly infested not a single scale could be found. In the 350 acre orange grove of E. J. Baldwin every endeavor previously made to clear the trees of the scale insect had been without success. A few ladybirds were procured and a man spent six weeks in superintending the colonization of the beetles and their larvæ in various parts of the orchard. After this time the insects had spread so rapidly that it was expected the orchard would be free from the scale in a few weeks.

The distribution of the parasites was under the control of a special commission. As the people came for the insects they were allowed to enter the tents and help themselves. Each orchard was a source of supply to contiguous orchards, and as a final result of the work the entomologist of the Department of Agriculture felt justified in writing in his annual report for 1889 that "the fluted and white scale is practically no longer a factor to be considered in the cultivation of oranges and lemons in California." At the same time he recognized the fact that the end was not yet; he believed it probable that the scale would recuperate and spread again, and that again the ladybird would have to be invoked to keep down the numbers of the pests. "This contest between the plant feeder and its deadliest enemy will go on with alternate fluctuations in the supremacy of either, varying from year to year according to locality or conditions, but there is no reason to doubt that the *Vedalia* [ladybird] will continue substantially victorious, and that the power for serious harm, such as *Icerya* [the scale] has done in the past, has been forever destroyed. We have learned, also, that it will always be easy to secure new colonizations of the *Vedalia* when such may prove necessary, or even new importations, should these become desirable" (p. 335).

It was found necessary in combating other scale insects to use other means, and for this purpose what is known as the hydrocyanic gas method is used. This method has only been introduced since 1887. Briefly speaking, the destruction is accomplished by means of an air-tight tent so arranged as to completely cover the infested tree and then fill the inside of it by hydrocyanic acid gas. This tent is raised from the ground by means of ropes and pulleys fastened to a standard which is itself placed upon a wagon bed, and so taken from tree to tree. Commonly there are two arms, from each of which a tent is suspended. Trees from 12 to 25 feet high can be fumigated by this apparatus (Fig. 5).

After the tent is placed in position the gas is generated. The materials consist simply of commercial sulphuric acid, fused potassium cyanide and water. The generator is a common earthen vessel and it is placed under the tent at the base of the tree. Water is poured into the vessel, then the acid, and lastly the cyanide. The operator withdraws to the outside of the tent and the bottom is fastened down by a few shovelfuls of earth. The tent is allowed to remain over the tree from 15 to 30 minutes, according to its size, and it is then withdrawn and placed over another. Experiments have shown that the gas is not injurious to the foliage at night, although it is during the day time, while it is more effectual in killing the insects at night. This process has been very extensively used in Southern California, and in 1892, in Orange County alone, no less than 200,000 orange trees were successfully treated.

(To be continued.)

ALLAMANDA FRUITING.

ALLAMANDAS are naturally valued chiefly for their flowers, but that their "fruits" or seed vessels are not without interest, our illustration will show. Were

FRUIT OF A SPECIES OF ALLAMANDA.

such a fruit seen without leaves, it might readily be taken for a thorn apple (Datura), but the internal structure is quite different, and the milky juice would be quite distinctive. Moreover, the Allamanda should have a pair of such thorny pods, but one only is developed in this case. The Allamanda flower is evidently pollinated by insects, but what the particular creature was who effected this result we do not know. —*The Gardeners' Chronicle.*

THE RIGHT TO TOP A NEIGHBOR'S TREES.*

LEMMON *v.* WEBB.—Lord Justice Lindley read his judgment as follows:

The plaintiff and the defendant in this case are adjoining landowners. Some old trees situate on the plaintiff's land had branches which projected over the defendant's land. The defendant cut off so much of these branches as projected over his land, and he did so without going on to the plaintiff's land, and without previous notice to him. The question is whether the defendant was justified in so doing. The action was brought to obtain a declaration that the defendant had no right to cut the branches at all, or, at all events, no right to cut them without previous notice to the plaintiff, and a request to him to cut them, and a non-compliance by the plaintiff with that request. It was contended on behalf of the plaintiff that, having regard to the age of the trees, and of the projecting branches, he had acquired a right to the exclusive possession of so much of the space above the defendant's soil as the branches actually filled. But to plant a tree on one's own land infringes no rights, and if the tree grows over the soil of another, no action lies for the encroachment unless damage can be proved. According to our law, the owner of a tree which gradually grows over his neighbor's land is not regarded as insensibly and by slow degrees acquiring a title to the space into which its branches gradually grow. Considering that no title is acquired to the space occupied by new wood, and that new wood not only lengthens but thickens old wood, and that new wood gradually formed over old wood cannot practically be removed as it grows, and considering the flexibility of branches and their constant motion, it is plain that the analogy sought to be established between an artificial building or projection hanging over a man's land and a branch of a tree is not sufficiently close to serve any useful purpose. The right of an owner of land to cut away the boughs of trees which overhang it, although those trees are not his, is too clear to be disputed. This has been declared to be the law for centuries, and there is no trace of the age of the tree or its branches being a material circumstance for consideration. Nor did Mr. Justice Kekewich intimate any doubt upon the law up to this point. He, however, held that notice ought to have been given to the owner of the tree before it was interfered with, and the real question is whether notice is required by law. The authorities do not allude to the necessity of notice. In "Pickering *v.* Rudd," which was an action for cutting the plaintiff's Virginian creeper, the plea contained no averment of notice. Lord Ellenborough held that the only question was whether the defendant had exceeded his right by cutting too much. The judgment of Mr. Justice Best in "Earl of Lonsdale *v.* Nelson" (2 B. and Cr., 311) is explicit that overhanging trees may be lopped by the owner of land over which they hang without notice. Mr. Justice Best says the right so to lop them is an exception to the general rule, which requires notice before a nuisance not created by the owner of what creates it can be abated by a person injured by it. He is not alluding to a case of emergency, for in such a case no notice need ever be given. He refers to such cases afterward. What I have above said respecting the right to cut branches is equally true with respect to the right to cut roots. The law on the subject is, in my opinion, as follows: The owner of a tree has no right to prevent a person lawfully in possession of land into or over which its roots or branches have grown from cutting away so much of them as projects into or over his land, and the owner of the tree is not entitled to notice unless his land is entered in order to effect such cutting. However old the roots or branches may be, they may be cut without notice, subject to the same condition. The right of an owner or occupier of land to free it from such obstructions is not restricted by the necessity of giving notice, so long as he confines himself and his operations to his own land, including the space vertically above and below its surface. The plaintiff contended that he was justified in cutting the plaintiff's trees because they were in imminent danger of falling, but this is not proved, and my judgment is not based on grounds of urgency. The appeal, therefore, must be allowed, and the appellant must have the costs of the appeal, and judgment must be entered for the defendant; but, having regard to the obscurity of the law as to notice, and to the very unneighborly conduct of the defendant, there will be no order as to the costs of the action.

Lords Justices Lopes and Kay read judgments to the same effect.—*London Times.*

* Court of Appeal, May 8, 1894, before Lords Justices Lindley, Lopes, and Kay.

THE SCIENCE OF VULCANOLOGY.*

VULCANOLOGY, or the science which deals with volcanoes and related phenomena, is a very important branch of geology—the science which treats of the earth's crust in general. Geology is yet hardly a century old; for before that time it consisted of little else than a collection of romantic hypotheses and incredible superstitions. This remark applies with still greater force to vulcanology, for the study of which it is necessary to possess an extensive knowledge of physics, chemistry and a well developed faculty of observation. For a century or two previous to the nineteenth, however, there were acute observers, and we in Naples well know such names as those of Sorrentino, Duca e Padre della Torre.

Toward the end of the last century the active and extinct volcanic regions of Italy attracted the attention of four great men of science, each of a different nationality. I allude to Spallanzani, Sir William Hamilton, Dolomieu and Breislak. Although their nationality was different, they had two merits in common—that of scientific truth and that of Baconian methods of reasoning. In other words, they were pure men of science, since by that term we understand one who observes carefully, records neither more nor less than he observes, and draws from these facts, and those collected by others, his conclusions, without disregard to a clear knowledge of the principles involved and without flights of imagination. It is, therefore, more to these four men that we owe the advance of human knowledge concerning volcanoes than to all the writers who preceded them.

In the first years of the nineteenth century vulcanological literature was enriched by many workers, because, as the allied sciences were then making great strides, they were able to offer to vulcanologists much more powerful and accurate means of investigation. Thus we had Humboldt, Scrope, Daubeny, Pilla and Gemmellaro.

Following these came a phalanx of illustrious students of geology, some of whom are still among us, while others, though dead in person, are living and immortal in the memory of man as heroes of science and of human knowledge. Among these we may enumerate Lyell, Dana, Scacchi, Palmieri, Silvestri and Phillips, while at present many younger and gifted investigators are not wanting.

No other branch of science has been so heavily burdened by extravagant hypotheses, which have so much retarded its progress, as that of vulcanology. It is not only in the first half of the present century, but even still that we find an extensive literature produced by men who advertised themselves as scientific investigators, when, in truth, they did little else but write memoirs and books to promulgate and sustain fantastic, extravagant, imaginary and impossible hypotheses. Nevertheless, among this chaff we not only meet with grain, but very good grain.

As a subject of study, Vesuvius holds the first place in all vulcanological investigations of this and the last century. A few figures will make this fact more evident. Some four years since my wife and myself collected the titles of books, memoirs and other writings

* Introductory address to a course of lectures on vulcanology, delivered in the R. Univ. of Naples, by Dr. H. J. Johnston-Lavis.—*Nature.*

referring to the South Italian volcanoes for the purpose of publishing a bibliographical list. We found the following numbers:

Graham's Island, or Isola Ferdinandea....	28
Roccamonfina	33
Lipari Islands........	119
Alban Hills........	210
Campi Phlegræi........	539
Etna........	880
Vesuvius........	1552

From this table it will be seen how much has been written concerning Vesuvius; in fact, its literature constitutes nearly half of what has been written about all the volcanic regions south of Rome. If we add to these the titles referring to the Campi Phlegræi, we then find that, in a total of 3,361, not less than 2,091 concern the volcanic district around Naples. Let me, however, give you a still more striking fact. The Naples branch of the Italian Alpine Club possesses the richest vulcanological library in existence. The catalogue contains more than 7,000 entries of papers, books and manuscripts. In this number, however, are included books that not only treat of vulcanology, but in large part refer to seismology and, to a smaller extent, to geology. It will be seen, therefore, that the Neapolitan volcanic district represents more than a quarter of all vulcanological literature.

It is true that the history of Etna and the Æolian Islands reaches farther back than that of Vesuvius, but, on the other hand, the history of this latter is by far the most complete. From a chronological point of view, Vesuvius and also the Campi Phlegræi hold a more important place in history than any of their rivals. Even if the Pompeians, the Herculaneans and the Stabians did lose all their property eighteen centuries since, the modern world has recovered it as archæological treasures, whose value represents, from the point of view of culture, many times the original and the compound interest on the same for the whole interval; and this we owe to our Vesuvius. The Phlegræn region around Naples is so enchained with the poetry of the heroic and classic periods, that without it the legends of Cuma, of Pitheeusa, of Spartacus, of Partenope, of Baja and so many others, which fill pages and pages of ancient history, would not exist.

Sometimes poetic ecstasy attacks the mind of the scientist; for, contrary to what the general public believe, science, rather than abolish poetic sentiment, further develops it, but in a more serious and refined form.

When, as we wander around Naples, we reach the hill of Cuma, and we encounter a few ruined walls and a few potsherds that peep out through the rich vegetation of that spot, where now the only inhabitants are the goats and the lizards, our imaginations speed back for nearly three millenniums, when this same rock, almost as in its present state, was chosen by the daring Greek navigators as the site of their new colonial town. All of us know the history of Cuma, all of us know that this little bit of Italy for one half of historic time held a very important place. We are deeply impressed when we make an effort to conceive clearly what 3,000 years really is, how many generations lived and died during that time and in that place; but far greater are we impressed when we think that 3,000 years is but a fraction in the *geological* history of that hill, and finally our mind fails to grasp the value of time when we consider that the physical record of this hill is not more than a minute fraction of the geological chronology of our globe.

Without going very far back in the geological history of our region, I will ask you to follow me to the first part of the Pliocene epoch, an epoch, as all know, to be considered quite near our own time. All of us now admire the beauty of the Gulf of Naples, which has few rivals in the entire world, but at that time its conformation was very different to what it is now. It then formed a very much larger gulf, represented to-day by the plain we call the Campania Felice, with a large part of the Terra di Lavoro. We must figure to ourselves a broad gulf limited on the north by the promontory of Gaeta, where its confines were limited by high limestone cliffs. Its coasts had roughly the following trend. From Gaeta it corresponded with the present provincial road to close under Castleforte, and from there was almost represented by the valley of the Garigliano as far as the gorge between Monte Faito and Monte Cammino, by which narrow strait it was in communication with the sea covering the plain Cassino. Winding round the south of Monte Cammino, it again extended northward to Mignano. The eastern coast of this strait corresponded with the present line of railway from Mignano to Taverna St. Felice, which coast, turning eastward, passed under Presenzano to extend into the mountains by the valley of the Volturno. From this point the coast, winding round several islands, represented to-day by hills and mountains separated from the main mass of the Apennines, it extended into these latter, forming so many fiords. The sea then covered all the plain, and its waves beat the foot of the mountains behind Pietramelara, Pignataro Maggiore, Capua, Caserta, Nola, Palma, Sarno, Angri and Castellamare, and then corresponded roughly with the present coast of the peninsula of Sorrento. In the middle of this great gulf rose two important isles—Capri and Monte Massico, besides a quantity of small ones. Numerous fiords penetrated the Apennines, where to-day we have the Garigliano, the Volturno, Valle di Maddaloni, Valle Caudina and the Valle di Avella. In fact, this part of the coast of Italy in those Pliocene times was very similar in configuration to that of the Istrian coast of to-day.

The rivers bringing down to the sea sand and mud, which, settling at the bottom of the gulf, prepared an almost flat marine floor, which later was to form the foundation of the Campanian Plain. At that period the Campania Felice was only sea, and where to-day flourish vines, oranges, lemons and gardens of flowers, then only grew marine algæ.

The great fissure in the earth's crust which corresponds with the western coast of Italy, and along which were formed the Italian volcanoes, opened a way for the igneous magma to the bottom of this gulf. Numerous eruptive centers were formed, giving rise to the volcanoes of Ischia, Roccamonfina, Campi Phlegræi and Vesuvius. The order in which these different groups were formed is still an unsolved enigma. Ischia, as has been long known, shows by the fossiliferous deposits clothing its flanks to have undergone great elevation since its original formation, and as we have no such evidence in the other volcanoes, we must conclude for the greater antiquity of Ischia. I also believe that the volcanic group of Roccamonfina is very much older than that of the Phlegræn Fields and Vesuvius, because we find the *piperno* and the *pipernoid tuff*, very old volcanic deposits in these regions, forming a mantle over Roccamonfina when it was almost a complete mountain. It must not be forgotten, however, that in the "Museum Breccia," first described by me, we have evidence of the effusion in these regions of many varieties of rocks long anterior to the *piperno*.

Gradually the large quantity of lava and fragmentary materials that were ejected at the bottom of the gulf greatly diminished its depth, and this, combined with general elevation, resulted in the emergence of a number of volcanic islands at Roccamonfina, Ischia, Naples; and probably Vesuvius was, at first, like the others, an island. Constant general elevation soon drove back the sea, leaving high and dry all that region we so well know. This plain, with its volcanic hills and mountains, constitutes one of the most beautiful, the most fertile, and the healthiest regions of our earth, if man were more capable of appreciating, enjoying and developing this *pezzo di cielo caduto in terra*.

So many are the advantages that Vesuvius offers to the student of vulcanology, that I think it advisable to pass them in review. This renowned volcano occupies a very central position in the civilized part of the globe, only a few kilometers from Naples, with all the resources of a great city, and in communication by numerous lines of passenger vessels and railways with all parts of Europe and America. Means of visiting Vesuvius are numerous, while the volcano is now entirely surrounded by a network of railways, besides good roads. By road and railway the top of the mountain can be reached, and upon its flanks can be found hotels and accommodation of all kinds, besides a meteorological observatory, intended to be used for the daily study and record of its varying phases. The simple but interesting form of the mountain, the extraordinary and unrivaled variety of its productions, which surpass in number, beauty, and interest those of any other volcano yet studied, are also a matter of maximum importance to the student. Besides this, of equal importance we must reckon that continuous activity with variation within such limits as to permit detailed study on the spot, and still more fully in the university laboratories or elsewhere.

Scattered over Italy, and within a few hours' reach, are several other active volcanoes, each having its own special interest, besides a large number of extinct ones and subsidiary volcanic phenomena, all of which, beyond their scientific interest, have a very great importance to the inhabitants from an agricultural, industrial, and hygienic point of view. This is especially the case in the immediate vicinity of the active ones, so that it becomes the duty of the government to maintain a system of observation and record, and to develop a school in which students may acquire a scientific knowledge of vulcanology.

At Naples we have a chair of terrestrial physics, but as under this name is included a vast amount of different groups of phenomena, it is impossible for its holder to give a fair share of vulcanology alone. So far, the only chair of vulcanology was that of Catania, which was so well occupied by the late Prof. O. Silvestri, and which, after his premature death, was abolished.

IN FRENCH INDO-CHINA.

THE leading article in the April number of the *Revue Francaise* is by Edouard Saladin. Under the modest title of "Notes de Voyage," he gives much interesting information regarding the French possessions in Indo-China.

In 1887, French Indo-China embraced the ancient empire of Annam (including Tonkin and Cochin China), Lower Cochin China and Cambodia, with a population in all of between fifteen and twenty millions. Since then France has gained considerable accessions from Siam, between which kingdom and Annam the boundaries were not well defined.

M. Saladin says: "The principal interest of my journey has been in the comparison which I have been able to make between the present condition of the colony and that twelve years ago. It will be possible for me to show that Indo-China has made considerable progress in these last years; that the work of civilization undertaken by our country in these distant lands has begun to bear fruit; that the sacrifices of men and money which we have made there are far from being lost, and that an immense field, widening every day, is already open to our activity."

M. Saladin's first landing place on French soil was at Saigon, the ancient cadital of Khmer, now a modern French city in Lower Cochin China. "It was situated," he says, "on the seaboard at the beginning of the Christian era. To-day it is a four days' journey by steam launch from the mouth of the Mekong or Cambodia. The delta of the river has grown in 1,900 years the entire length of Cochin China and the kingdom of Cambodia; while the ancient kingdom of Khmer has most its conquests north of the shore of Annam and of the valley of the Mekong."

From Touraue, on a fine harbor on the coast of Annam, M. Saladin followed a river to a coal mine at Noug-Sou, which it was one of the objects of his trip to visit. This river, called for a part of its course the Song-thu-Bong, traverses a very fertile and populous plain, in which rice is principally cultivated. "On each bank there are large villages hidden under bamboos and betel nut trees. I disembarked at nightfall with my companion M. Beauverie to dine in the ruins of a little abandoned pagoda. There we were surrounded by a curious and very familiar crowd of people from the neighboring village. We amused ourselves and puzzled them by giving them little pieces of ice, which they passed from hand to hand, without understanding anything about the extraordinary temperature of the (to them) unknown substance. . . . The line of railway projected between Touraue and the Mekong will probably pass through this valley."

After speaking of the legend of a dragon, which was the special protector of the royal family of Annam, and whose home was in the Noug-Sou mine, a legend which had saved it from being worked out, the writer briefly touches upon the plant and buildings put up by the French company which now works the mine. He then describes at length a tiger chase, of which he was the hero.

By way of introduction, he speaks of the valuable services which a "boy" (the English word is used) renders to the foreigner in that part of the world. His own was laundress, cook, chaser, and preserver of butterflies, etc. Then comes the hunt:

If the "boys" render many services, there is one which can scarcely be expected of them—that is, to defend you from tigers during the night. All the Annamites have a respectful fear of that creature, and many of the villages have on their gate a horrible portrait of the animal, violently colored, evidently intended to make him flee before his likeness.

However, when one of these too numerous tigers makes too large demands upon a village, the people, with all the forms of respect imposed by ancient custom, take measures for its destruction. I asked my interpreter one day what a little structure, firmly placed at the entrance of a village, could be. "It is a little pagoda, for killing M. Tiger," he replied. Sometimes a village cannot have the expense of a trap like the one I had just seen, and the affair is managed in another way. It was on this account that I was myself concerned in a fight with a tiger, from which a providential circumstance happily allowed me to escape without serious wounds.

I was very prosaically occupied at the house of my host, M. Beauverie, director of the Noug-Sou mine, examining the accounts of the mine, when, about six o'clock in the morning, we saw the mayor of a neighboring village arrive, dressed in his beautiful black silk robe, worn on high days. He explained to us with force that M. Tiger having become troublesome, the village had surrounded him; that he had been inclosed in a great net, where we could see him at a distance of ten meters. The mayor begged us to come with our guns and kill the animal, which, with his weapons, he could not do. Indeed, the villagers are not allowed to possess fire arms, and it was only with two lances, authorized by the rules, that the poor people could rid themselves of the carnivorous creature.

A tiger hunt was scarcely a part of the programme of my mission; but ought we not to go to the rescue of the villagers, who often furnished workmen in the mines? Then the tiger was inclosed in a net. We could hardly refuse a service asked of us, and, besides, if we did refuse, it would hardly enhance the national *prestige*, upon which was based, in reality, the absolute security which we enjoyed, so far, from every French post. This fine line of reasoning once formulated and our scruples quieted, we rapidly placed our guns, our breakfast, and our photographic apparatus on a boat. We must try to make an "instantaneous" of this tiger in a net, so rare an opportunity was promised.

Two hours of *sampan*, occupied by breakfast and the numerous plans for the battle, brought us to the village, situated up the river from the mine.

The mayor led us rapidly toward the inclosure, and it was under a leaden sky, at 1 o'clock in the afternoon, that we saw the *rabatteurs* (natives who drive up the prey) and the hoax. A great circle of *rabatteurs* was formed in the rice fields, not less than 150 meters in diameter, around a long, dense thicket, in which we could distinguish nothing. A net, a dozen or so meters long, figured in the circle—the snare of which we had been told. There was, indeed, a net, and there was a tiger, but one was not in the other, and it is precisely under such circumstances that a man understands the *finesse* of the Indo-Chinese diplomacy.

We leave our photographic apparatus and begin to make the round of the inclosure to try to see "M. Tiger," and to draw him out. M. Beauverie has armed his "boy" with a two-barreled gun loaded with buck shot and we have each a Winchester rifle.

We perceive nothing at all, when behind us two quick shots are fired, to which a superb bass voice from the interior of the thicket responds with a prolonged roar. The "boy" has seen straight, for a second after, I perceive behind this horrid thicket a yellow zebra with a long croup, which is running at a little gallop in the rice field, evading the hunters and gaining another covert. It is impossible to send a ball under these conditions, in the midst of the *rabatteurs* who fall back, letting the growling animal pass them, and we now, with a great re-enforcement of *tamtams* and cries, surround a second thicket, much larger than the first and which covers nearly an acre.

Several *rabatteurs* assure us that the tiger is resting there; we doubt it a little, but as they insist, we make a last trial, which seems to us of very little use, as the tiger has had time to escape. The contrary was clearly proved. Entirely ignorant of their habits, M. Beauverie and I take two sides of the rectangle occupied by the thicket and we have a group of *rabatteurs* advance to drive out the beast on one of the sides which we guard. The time is passing and the sun is becoming intolerable; we are on the point of going away, seeing nothing, when the *rabatteurs* call me to show me a fresh trace which they have just discovered.

I approach them and perceive, indeed, a trail in the grass, at the foot of the bushes and at the edge of the jungle. Nothing stirs in the low brushwood. At any rate, I direct my rifle along the trail, fire, and quickly reload. Scarcely have I closed the breech when I perceive, a meter from my guidon, the figure of a tiger coming rapidly upon me. I wait an instant, and without shouldering the gun I press the trigger just as he is about to touch my arm. I hoped to arrest him, but he has not had enough; he shudders, then crouching, he throws his fore paws upon my hands, while I hold his head with the end of my gun; he raises himself, and gives me his open mouth straight in my eyes. How did I think then to put my rifle across his mouth? How did I succeed in that classic performance, how in repelling his attack with all my strength? I had scarcely time to find out. But the shock was so violent that I found myself thrown three meters from there, upon my back, having made a complete volt, while the animal remained crouching in the same place, his paws upon my Winchester. This unenviable position was more favorable than the preceding one, for immediate contact had ceased. I had disappeared in the tall grass, and the *rabatteurs*, who were making an infernal noise with their *tamtams* a few steps from me,

ought, rather than a pseudo corpse, to attract the attention of the tiger.

M. Beauverie had not understood my shots, not seeing anything move in the jungle. A native seized him by the arm and led him toward me, showing him soon the head of the tiger emerging from the high grass and looking at him. At a distance of scarcely five meters he saw him well; at the first ball the tiger shook his head; at the second, let it fall on the breast; finally, at the third he lay stiff. I got up and bound up my wounds with my handkerchief, very happy to have escaped with only a gash on the back of each hand. The animal which gave us all these emotions was a young tigress measuring between six and a half and seven feet from the mouth to the end of the tail. The autopsy revealed five balls in different parts of the body.

M. Saladin gives an account of a curious quarrel among the people at Haiphong. They are divided into two parties on the question whether the trees shall be cut to allow the wires for electric lights to pass, or whether they will not have the lights and allow the trees to grow. The wires were placed over the trunks of some young, newly-planted trees; they have grown rapidly, and the wires have become so entangled in the branches that the lighting has been prevented. The people who use the walks in the daytime protest against the cutting off of the troublesome branches and favor cutting the cables; on the other hand, those who are abroad at night have come to the rescue of the obnoxious cables, and if blood is not shed over the matter it will be strange, for the discussion has been very warm and continues to this day.

I remained several days at Hanoi before continuing my journey in Tonkin, but the time was too short for me to see everything of interest which the city contains. Hanoi is developing rapidly. A paper mill and also a match factory have lately been built, and are now in operation. There is an important silk spinning establishment carried on after European methods; the work on a cotton spinning mill is well advanced and should be completed in 1895. The country produces a special quality of cotton of short fiber; they have imported some from Georgia, which thrives well. Many other plants flourish, if we may believe the kind director of the botanical garden at Hanoi, M. Martin. He showed us tea, coffee, sugar cane from Java, jute hemp from Manila, etc.; all the plantations very thrifty and giving fine harvests. Cauliflowers attain colossal proportions.

If one believed some planters, all these results must be considered factitious; but if one studies the question a little, he finds that the soil of the botanical garden is very different from that in which some of the unsuccessful attempts at cultivation have been carried on. The fertility of the soil of Tonkin is indisputable. A part of the delta gives two crops of rice annually; it is a raw product, of which 30 for 1 are obtained without fertilizers. But these results are due to the cultivation by irrigation. The water of the rivers, charged with organic matter, is an excellent fertilizer; vegetation here has the same conditions as those found in the delta of the Nile, and as the better irrigated lands cost less than 350 francs an acre, and labor is still very low, one can undertake its cultivation at a great advantage.

M. Saladin devotes considerable space to the subject of pirates and piracy, as they were established in Tonkin until a few years ago, and writes with emotion of Cruvelier and his men, through whose bravery and sacrifice they were dislodged.

The coal mines at Ke'bao, in Tonkin, near the Chinese frontier, are important.

At present not more than 300 tons a day are taken out, but the deposits are very extensive and rich. The company working the mines has, so far, given most attention to the subject of providing means of transportion of the coal.

M. Saladin, in closing his notes, speaks of the thorough support which the local government in Indo-China gives to French enterprise.

[FROM THE INDEPENDENT.]

AN EXCAVATION CAMPAIGN IN ERETRIA.

By Prof. RUFUS B. RICHARDSON, Ph.D., Director of the American School of Archeology in Athens.

IT was with some surprise that at the end of one week's work here we found that we had already achieved a success in excavation such as to draw people to look at the work and to secure the attention of the press.

Success in excavations is usually a result of a combination of calculation and luck. Our success has seemed to be very much an affair of luck; and yet calculation came in for its share. Last winter in a short visit to Eretria I had made a memorandum of five things to be done if I were able to begin work there in the spring, and the first on the list was to dig some trenches in the rear of the theater which was excavated by us three years ago. It had seemed to me ever since I was here at that time (an opinion shared by others) that there would be likely to be a temple of Dionysos somewhere near the theater. In some excavations, as at Olympia and Delphi, Pausanias has been an invaluable guide; but as neither he nor any other writer has told us anything of the topography of Eretria, calculation was here reduced to more or less prudent guessing. In this case our guess was right. We did not lose an hour's time when we got our men together and began work.

Getting the men together was indeed a rather difficult process. Eretria is a small and poor village, and, as it is now harvest time, I was told that not more than ten laborers could be secured here. It was fortunate for us that we had time to reflect on the situation. We landed from the steamer on Thursday, May 3, and found that we could not begin before the following Monday, because Friday and Saturday were two of the greatest holidays of the Greek year. After sending to a nearer place, I sent our invaluable Greek helper to Chalkis with instructions to go on, if need be, to the Peiræus, and bring us forty men by persuasion or force. By paying a rather high price he secured the men in Chalkis, and when they came filing into our camp Sunday noon they looked like a set of vagabonds. In fact, some of them have attracted more of the attention of the Eretria military police than I like. The people in Eretria, hearing of the higher price, also begin to come in and enroll themselves. Some come from Kyme, on the other coast of Eubœa, and five even come across from Oropos.

Thus we were able to start on Monday with a force of between sixty and seventy men. The women of Eretria are now doing most of the harvesting in the fields. I ought to add that the high wages which I am paying are, at the present awfully depreciated value of the Greek drachma, only forty cents. This is small pay for a day of nearly twelve hours—viz., from sunrise to sunset, with half an hour at eight o'clock for breakfast of bread, olives and cheese, and an hour and a half at noon for a dinner of the same material. A great many of the men do not seem to earn any more than these wages.

Our excitement was intense when in the course of our first forenoon we struck a broad platform of a building only about sixty feet from the theater. In the course of the day we ascertained that this was forty feet broad. The next day we discovered its length, which was about seventy feet. This platform was very near the surface, and was very accessible. Our great work was to dig all around this and see how deep were its foundations, and also clear out places in the middle of it, for it was not a continuous platform, but had a considerable open space in the middle, as befits the stereobate of a temple. On Saturday evening, having worked without interruption (it does not rain here at this season of the year), we had done our work, and when the whole platform was swept off and exhibited its three massive layers all around, making a total of four and one-half feet of depth, it looked so fine that we felt proud of it. We had made a substantial contribution to the topography of this noble, old, ancient city.

Probably few will be disposed to dispute the name which we provisionally give the building, viz., the Temple of Dionysos. That is what we looked for, and we seem to have found it. Unfortunately we found no inscription that would make this sure. All the architectural members of the temple, such as columns and entablature and one or more layers of the platform, have disappeared. The temples of antiquity were always the quarries of later generations, and this temple probably lay long on the surface inviting to plunder.

During our second week we have cleared the ground to the east of the temple, laying bare what seems to be a great altar. This lies in the rear of the stage building. Then, digging from the north side of the temple, we have discovered a stoa of considerable extent leading out of the west parados of the theater. Perhaps our most valuable discoveries from a scientific point of view are being made in this west parados, which had hitherto been neglected. Of this it is too early to speak.

Simultaneously with the work on and around the temple, we have excavated a part of a street not far away, where the foundation walls protruded from the ground. We have also uncovered several water conduits and an interesting series of four large stone tubs, from one to the other of which water used to run. These are numbered A, B, Γ, Δ, and we have christened it "the city laundry."

A thing which has attracted a good deal of the wondering attention of the workmen and visitors is a well-walled shaft adjacent to the south wall of the temple. This was cleared very slowly, as only one man could work in it at a time. After going down ten feet it opened into a lateral passage, which ran on so far that "bottomless pit" became a current designation for this enigmatical affair. The workmen, who see graves in everything and expect treasure everywhere, have been greatly disappointed because the only things hitherto brought out have been bones of animals, a cow's horn and jawbone being particularly well preserved. What we should have been very glad to make into a subterranean treasury, or even into an ancient wine cellar, may have been a sacrificial pit; but we are not yet through with it, and the fact that there are carefully cut holes for feet in two of its sides indicates that people went down into it.

We have also made the first serious excavations yet undertaken with a view to locating the temple of Artemis Amarysia, the most famous temple of the Eretrians, a mile outside their city wall. We failed, finding only walls of a later time. We have simplified the problem for our successors by eliminating one of the possibilities. No one need dig again at the foot of Kotroni.

Another interesting work has been the opening of a large tumulus like that on the plain of Marathon, containing the bones of the Athenians who fell in the battle. After cutting three roads into it and going down in the center to a depth of twenty-five feet, carrying out the earth with wheelbarrows, we were forced to the melancholy conclusion that somebody had been there before us. As the mound looked practically intact from the outside, and as not even the oldest inhabitants know anything of these previous excavations, our predecessors may have done their work many years ago and covered its traces quite effectually.

We find to our surprise that the central core of the mound is a stone tower twenty feet high and fifteen feet square. Our predecessors had broken away over half of this on the southern side until they came to the bottom, where they appear to have found the tomb which they sought. They must have worked from the top with crowbars and baskets.

In the course of our work about the temple we have found some objects of minor importance, among which a pretty statuette head of Aphrodite in marble holds the first place.

We are living in tents secured from the Greek government. As our workmen from Chalkis could not all quarter themselves in the town, we gave up one of these tents to twenty-five of them, who somehow managed to sleep in it.

The long hours of the Greek working day have made our work a real campaign with its real hardships. When one is on his feet most of the time, pressing on the workmen, from five o'clock in the morning till seven o'clock in the evening, one is disposed to go to sleep promptly. But both I and my fellow-workers, Profs. Phillips and Capps and Dr. Peabody, have enjoyed the work with an intensity of enjoyment which one rarely gets.

I may add, in closing, that one result of our work is that we probably now know where to dig with good results for more knowledge of Eretria.

Eretria, May 20, 1894.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

o dig with good

pplement.

r.

a Year.

scribers in any
. Six dollars a
try.
MENT, from the
be had. Price,

MENT can like-
issued yearly.
paper, or $3.50

NTIFIC AMERI-
RICAN SUPPLE-

ws agents, and

ers,
York, N. Y.

TS.

S.

tained in Sci-
g the past ten
; also, a com-
by different
subjects, has
lation, at the
d with names
e only to ask
dress

New York.

TS!

ion with the pub-
ontinue to examine
inventors.
s' experience, and
Patent Drawings,
or Patents in the
Munn & Co. also
or Books, Labels,
ts of Patents. All
d promptness, on

taining full infor-
ections concerning
es, Infringements,
tents, etc.
Patent Laws, show-
principal countries

ents,

Pacific Building,